SmartReader Plus Data Loggers

Reference Guide

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

SmartReader Plus Data Loggers

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

All rights reserved. No parts of this work may be reproduced in any form or by any means - graphic, electronic, or mechanical, including photocopying, recording, taping, or information storage and retrieval systems - without the written permission of ACR Systems Inc.

Products that are referred to in this document may be either trademarks and/or registered trademarks of the respective owners. The publisher and the author make no claim to these trademarks. For more information regarding trademarks, see the "Trademark Notices" section of this manual.

ACR Systems Inc. assumes no responsibility for errors or omissions, or for damages resulting from the use of information contained in this document or from the use of programs and source code that may accompany it. In no event shall the publisher and the author be liable for any loss of profit or any other commercial damage caused or alleged to have been caused directly or indirectly by this document.

TRADEMARK NOTICES

SmartReader Plus is a Registered Trademark of ACR Systems Inc.

LIMITED WARRANTY

ACR Systems Inc. warrants the hardware to be free from defects in workmanship and components for one year from the date of purchase, provided they are not abused or subjected to detrimental conditions.

Software is warranted for one year from the date of purchase, to operate in accordance with its programmed instructions. It is not warranted to be error-free. If the product does not perform in accordance with this Limited Warranty, ACR will at its discretion, either repair or replace the product free of charge. There will, however, be a charge for freight and Canadian Customs clearance (if applicable). Any replacement hardware or software will be warranted for the remainder of the original warranty period. To the maximum extent permitted by applicable laws, ACR Systems Inc. disclaims all other warranties, either expressed or implied, including but not limited to, implied warranties of fitness for a particular application. In no event shall ACR Systems Inc. be liable for any inconveniences, loss, damages, etc., whatsoever arising out of the use of this product.

ACR's policy is not to proceed with any repairs or replacement unless first discussed with ACR's Technical Support Analysts and an RMA (Return Material Authorization) number is issued.

Table of Contents

Section I SmartReader Plus Data Logger 1

1 Introduction to SmartReader Plus Data Loggers 1

Features 1

Description 1

Programmed Operation 2

How SmartReader Plus Loggers Take Readings 2

How to Use SmartReader Plus Loggers 3

Specifications 5

Product Approvals 7

2 SmartReader Plus Software Driver 8

Logger Status 9

Logger Sampling 10

Fast Sampling 10

Logger Memory 11

Logger Alarms 14

Delay Before First Call 15

Delay Between Calls 15

Delay After Backup 16

Baud Rate 17

Alarm Dialout String 18

Logger Channels 19

Channel Information 19

Channel Alarms 21

Channel Calibration 21

Logger Connection Settings 22

3 SmartReader Plus 1 Temperature Logger 26

Description 26

Setup 26

4 SmartReader Plus 2 Temperature & Relative Humidity Logger 28

Description 28

Setup 28

Accessories 29

Troubleshooting 30

Relative Humidity Calibration 31

Specifications 31

5 SmartReader Plus 3 Current, Voltage and Temperature Logger 33

Description 33

Setup to Measure Current 34

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Voltage Channels **35**
Current Probes and Accessories **36**
Specifications **36**
Troubleshooting **37**
6 SmartReader Plus 4 Pressure, Temperature and RH Logger 38
Description **38**
Setup **39**
Pressure Calibration **40**
Specifications **41**
7 SmartReader Plus 4 Low Pressure Differential and Temperature Logger 42
Description **42**
Setup **42**
SRP4 LPD Pressure Specifications **43**
8 SmartReader Plus 5 Thermocouple Logger 44
Description **44**
Setup **44**
Use **44**
Specifications **46**
Manual Calibration **46**
9 SmartReader Plus 6 Thermocouple Logger 47
Description **47**
Setup **47**
Use **48**
Specifications **48**
Manual Calibration **49**
10 SmartReader Plus 7 Process Signal Logger 50
Description **50**
Setup **50**
Choosing Input Channels **52**
Customizing Input Ranges **53**
Selecting Transducers and Transmitters **57**
Specifications **58**
11 SmartReader Plus 8 Eight-Channel Temperature Logger 60
Description **60**
Setup and Use **60**
12 SmartReader Plus 9 Pulse Logger 62
Description **62**
How the SmartReader Plus 9 Counts **62**
Setup and Use **63**

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Specifications ... 63
13 SmartReader Plus 10 RTD Temperature Logger ... 65
Description ... 65
Setup ... 65
Specification of RTD Channels ... 66
14 Conservation Logger Temperature, RH and 5V Input Logger ... 67
Description ... 67
Setup ... 68
Accessories ... 68
Relative Humidity Calibration ... 68
Troubleshooting ... 69
Specifications ... 69
15 APPENDIX A Monitoring Resistance and Switch Status ... 71
Measuring Resistance ... 71
Monitoring Switch Status ... 71
16 APPENDIX B Temperature and Relative Humidity Calibration ... 73
Temperature and Relative Humidity Calibration ... 73
Thermistor Calibration ... 73
Relative Humidity Calibration ... 76
17 APPENDIX C Thermistor Temperature Probes ... 79
Thermistor Temperature Probes ... 79
What are Thermistors? ... 79
ET Series Temperature Probes ... 79
Setup and Use ... 80
Specifications ... 81
Resistance vs. Temperature Tables ... 85
Custom Probes ... 90
18 APPENDIX D Typical SmartReader Plus 3 Connection Diagram ... 91
AC Current and AC Voltage Recording ... 91
AC Voltage Transducer Specifications ... 92
19 APPENDIX E Sample Rates ... 94
How a Data Logger Stores Readings ... 94
Sample Rate Tables ... 94
20 APPENDIX F Connecting Multiple Loggers ... 100
Network Configurations ... 100
Basic Network ... 101
Modular Network ... 102
Shielded Network ... 103
Connection Problems and Solutions ... 103

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Index 105

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

WELCOME

Congratulations on your purchase of a SmartReader Plus data logger. We are confident that you will find it to be a most valuable and useful tool for your data collection applications.

This Reference Guide is designed to be used hand-in-hand with TrendReader 2.0 software and frequently refers to TrendReader 2.0 conventions and procedures. To get the most from your logger, please take time to familiarize yourself with TrendReader 2.0 and its Reference Guide.

For important information on how all SmartReader Plus data loggers work and how to use them, read the Introduction to SmartReader Plus chapter. It will give you an overview of how the loggers work and how to configure them for your application. Next, read the chapter that deals specifically with the type of SmartReader Plus logger you have.

SECTION 1 SmartReader Plus Data Logger

1.1 Introduction to SmartReader Plus Data Loggers

SmartReader Plus data loggers are easy-to-use, battery-powered data loggers. Pocket-sized and rugged, they can be used in a wide range of environmental and industrial applications. Different SmartReader Plus models are available to directly measure and record variables such as temperature, relative humidity, pressure, electric current, analog voltage, current loop and pulses. Each model can reliably record time-based data for later analysis by TrendReader software.

TrendReader software must be installed and ready to run prior to making use of the setup instructions in this section of the guide.

1.1.1 Features

SmartReader Plus data loggers share many common features that make them useful tools for data collection:

- Pocket-sized
- Solid-state components - no moving parts
- Low-power microprocessor controlled circuitry
- 12-bit high resolution readings
- Precision on-board thermistor temperature sensor (except the SmartReader Plus 9)
- High capacity lithium battery
- Quartz clock crystal
- Magnetic backing and secure locking hole
- Rugged die-cast Noryl® case
- Convenient terminal block connector

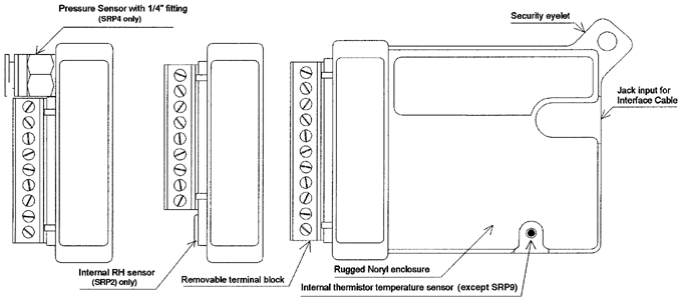


Figure 1: SmartReader Plus data loggers

1.1.2 Description

SmartReader Plus loggers can run continuously, constantly measuring and recording readings from any enabled channel. They can also start logging at a specified time. Self-powered by a

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

long-life lithium battery that will provide years of reliable operation, your SmartReader Plus can work independently from any external power supply or computer. When you are ready to look at the data it has collected, it can transfer all information to your computer through the use of TrendReader software.

Main Components
The main components of the SmartReader Plus data loggers include:

- a memory chip that has the capacity to store up to 1 million readings (see **Specifications**)
- a microcontroller and 12-bit analog-to-digital converter (A/D) that converts all input signals to digital values
- a quartz clock crystal that accurately keeps track of time and regulates the taking of readings
- an accurate on-board thermistor (except the SmartReader Plus 9) that the logger uses to measure ambient temperature via changes in resistance
- a lithium battery that provides power to the logger and internal or external sensors

1.1.3 Programmed Operation

SmartReader Plus data loggers run according to settings that you program. These pre-selected settings are stored in the logger's memory and instruct it to:

- take readings at regularly spaced intervals either at slow or fast sample rates
- take readings from specific channels that you enable
- associate each channel with an equation in TrendReader software
- start readings with or without a delay
- take readings continuously, or stop when memory is full

1.1.4 How SmartReader Plus Loggers Take Readings

Each SmartReader Plus data logger (except the SmartReader Plus 9) has an on-board thermistor that you can use to record ambient temperature. Depending on which SmartReader Plus model you have, you can turn this temperature-monitoring capability on or off using software. You can also record other information by connecting sensors, transducers or external circuitry to the plug-in terminal block.

SmartReader Plus data loggers can record readings in two selectable modes:

1. First-in, First-out (FIFO)*. In this mode the logger continues to take readings when its memory is full (to make room, it discards the oldest reading every time it adds a new one). Thus, the memory will contain a "sliding window" of information.

2. Stop when Full. The logger stops recording when its memory is full.

* Not available in "Fast Mode."

You can set the time interval at which your logger saves readings using TrendReader software. The sample rate you select will apply to all enabled channels. At a sample rate of eight seconds, one reading is taken every eight seconds and saved to memory. As you slow

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

the sample rate the logger begins to average readings before saving them to memory. To do this the logger takes a reading every eight seconds, but instead of transferring this directly to the logger's memory, it stores the readings in a buffer (a temporary memory) where it is retained until the sampling interval is over.

When you backup a logger's data to your computer, the correct time and date are referenced to each reading. All readings are then individually time and date stamped and processed by an equation associated with each logger channel. The result is a collection of accurate time-based data ready for detailed graphing and analysis.

1.1.5 How to Use SmartReader Plus Loggers

Using your SmartReader Plus data logger for most applications is a simple process. With proper planning, setup and installation of your data logger, you can be assured that the information you collect will be both correct and useful. The following provides general procedures for using SmartReader Plus data loggers. For additional and specific information on these steps, refer to the chapter in this manual that deals with your particular SmartReader model.

Planning

Proper planning is the key to successful data logging. Time spent in this stage will help you save time and frustration later. To help you plan, answer these questions:

- *What exactly do I want to measure?*
- *Where is the best place to measure?*
- *How long do I want to monitor for?*
- *Should other variables be monitored simultaneously?*

Setup

To set up your SmartReader Plus data logger you must first have TrendReader software installed and running on your computer. You can then configure your logger with various options by talking to it via the interface cable.

Set Sample Rate

Always confirm the sample rate (how often the logger saves readings) to make sure it will be acceptable for your application. You can alter the frequency at which your SmartReader Plus logger records readings by changing the sample rate. You can choose rates from 8 seconds to 8 hours in the normal mode. In Fast Read mode, you can select between 0.04 seconds and 2 minutes, with the use of an external power supply or battery pack. The sample rate chosen will apply to all the active channels on the logger.

To help determine which sample rate you should choose, answer these questions:

- *How long do I need to record data?*
- *How much time will elapse between when I retrieve the logger and download the data to my computer (for example, the trip back to the office)?*
- *How often do readings need to be taken?*

NOTE: To activate readings in the Fast Read mode, an external power source

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

must be connected to the data logger.

Making External Connections
If you are using your SmartReader Plus data logger to monitor external modules, sensors, or circuitry, make sure the connections are tight. Also, make sure the terminal block is snapped securely into the logger.

For permanent applications, wiring connections can first be made to the logger's removable terminal block. The terminal block can then be attached (with glue for example) to a permanent fixture. When it comes time to analyze data, the logger can simply be unplugged from the terminal block and brought back to your computer. After backing up the data, the logger can be returned and plugged back into the terminal block. Extra terminal blocks are available from your sales representative. When unplugging the terminal block from your logger, use care to pull it straight out so as not to break the plastic casing.

Enable Channels
Always make sure that you have enabled and verified the correct channels for your application. This is very important as it can be distressing to find out later that the information you hoped to collect was from an inactive channel. You can selectively enable additional channels in your SmartReader Plus as required. However, in order to avoid using logger memory unnecessarily, disable any channels which are not required.

Clear Memory
Before starting a logging session, clear the logger's memory. This will help to keep the collected files smaller as well as decrease the time needed to backup the logger later. Note that clearing the memory is automatic if you save setup changes (for example, assign different equations, change sample rate, etc.).

Test
You can directly read the values that your SmartReader Plus data logger is sensing using the Realtime capability of TrendReader software. This test gives you the opportunity to check your logger setup and make any necessary changes before starting the logging session.

Label
If you are working with more than one data logger, label each logger, identifying the task and location before you distribute them throughout a building or system. To do this, you can simply use a shipping tag. Later, when you retrieve them to graph their data, you will know what each graph refers to.

Mounting
Use the magnetic backing to conveniently mount your logger on metal surfaces like ductwork or electrical control cabinets. If you are concerned about theft, lock your logger to a permanent fixture using the locking tab or take advantage of its small size and hide it completely out of view. Because SmartReader Plus loggers are so light, you can use special mounting fasteners like Velcro® to attach them to almost any surface. Make sure your logger's mounting method will last the full length of your logging session.

Do not rely on the logger's magnetic strip for adhesion if the mounting surface is uneven, unstable or above 65°C (150°F).

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Cold or Humid Environments
Make sure that the environment you will be placing your logger into will be acceptable by referring to the Specifications in this chapter. If conditions are not adequate for the logger, consider using a protective enclosure. For humid conditions you can protect your logger simply by placing it in a zip-lock plastic bag.

When you place your SmartReader Plus logger in a cold environment, make sure condensation will not settle on the logger when you bring it back into warmer surroundings, such as an office. The best way of preventing moisture is to place the logger in a container and include a desiccant (a material that absorbs moisture). When you bring your logger back to your computer, leave the logger in the container until it has had a chance to warm up to the surrounding temperature. You can then take it out and analyze it.

Keep Track
Make sure you keep a record of where you have placed each logger in a building or system plan. You will save time looking for them when your data gathering session is over. Also, keep track of when you placed the loggers in the area you are monitoring. This will help when producing graphs on your computer. It may be helpful to label (shipping tag) each logger so you can properly identify and differentiate it from other loggers.

Analysis
After sufficient time has passed for the logger to obtain a representative profile of data, it is time to analyze the information. If you are retrieving the logger from the field, bring it back immediately to your computer for analysis.

In order to analyze your SmartReader Plus logger's data, you must first transfer a backup copy of its data to your computer. To do this, see Backup in the TrendReader guide. After transferring your information to the computer, the data is automatically copied to disk and time and date stamped.

You can find a detailed description of all software functions in the TrendReader guide.

1.1.6 Specifications

General

Size:	107 x 74 x 22mm (4.2" x 2.9" x 0.9")
Weight:	110g (3.75 oz.)
Case Material:	Noryl® Plastic
Operating Limits:	-40 to 70°C (-40 to 158°F) and 0 to 95% Relative Humidity (non-condensing)
Clock Accuracy:	±2 seconds/day
Battery:	3.6 Volt Lithium, 1 Amp-hour

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Memory Sizes:

Model	Readings	Bytes
32 KB	21,500	32 KB
128 KB	87,000	128 KB
1.5 MB	1,048,000	1.5 MB*

*See specific model for availability.

Sampling Methods: **1**. Continuous (First-in, First-out)*
2. Stop when full (Fill-then-stop)
*Not available with sample rates faster than 8 seconds.

Sample Rates: User-selectable rates from 25 per second to every 8 hours. (BP-101 battery pack required for sample rates less than 8 seconds).

Resolution: 12-bit (1 part in 4096)

Power Consumption: 5 to 10 microamps (continuous)

Battery Life: Ten years (under normal use) factory replaceable.

External Connector: Removable screw-type terminal strip with Common (-) connection.

Resistance to X-rays: Tested for protection against a 160kV 150mA-sec. dose @ 38" FFD (about 100times that of an X-ray machine). Tested for protection against Gamma Ray (equivalent to 0.137-1.38 megavolts) IR192-28 curies @ 30-second exposure source to object distance 5".

Internal Temperature Sensor*

Type: NTC thermistor; 10k ohms at 25°C (77°F)

Range: -40 to 70°C (-40 to 158°F)

Accuracy: ±0.2°C between 0 to 70°C (±0.3°F between 32 and 158°F)

Resolution: 0.03°C (0.05°F) at 25°C (77°F)
Better than 0.07°C (0.12°F) between -25 and 70°C (-13 and 158°F)
Better than 0.13°C (0.23°F) between -40 and -25°C (-40 and -13°F)

Equation: Use Equation 45 in TrendReader software

Specifications are subject to change without notice.

* The SmartReader Plus 9 does not have an on-board temperature sensor.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.1.7 Product Approvals

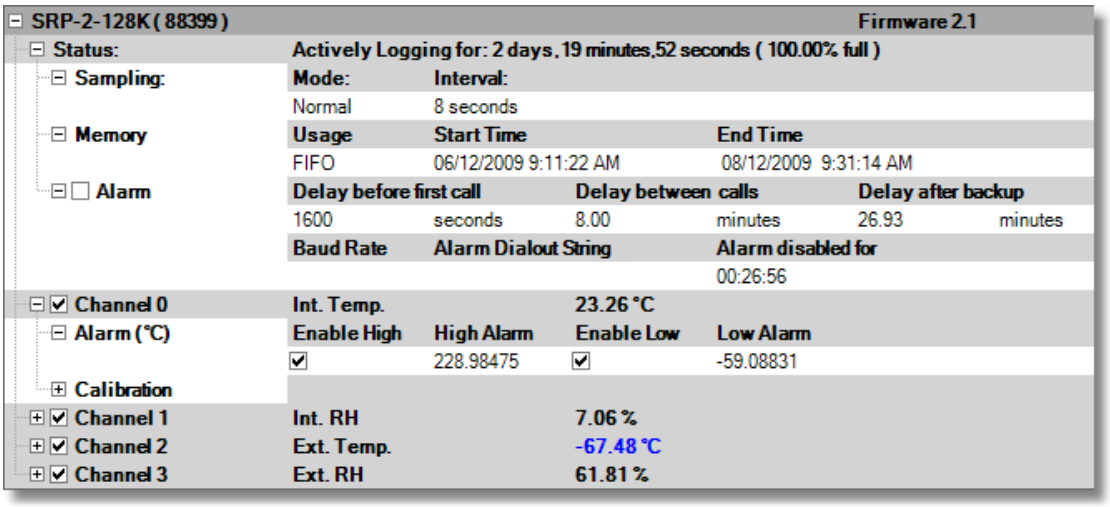
Meets Part 15 for Digital Devices of the Code of Federal Regulations of the Federal Communications Commission (FCC). Meets Class A radiated and conducted emission requirements of Section 2 of the Radio Interference Regulations of Communications Canada, IEC801-2, 3, 4 and EN55011 covering ESD, RFI Immunity, EFT/Burst and Radiated Emissions respectively for the Commission of the European Communities (CE).

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.2 SmartReader Plus Software Driver

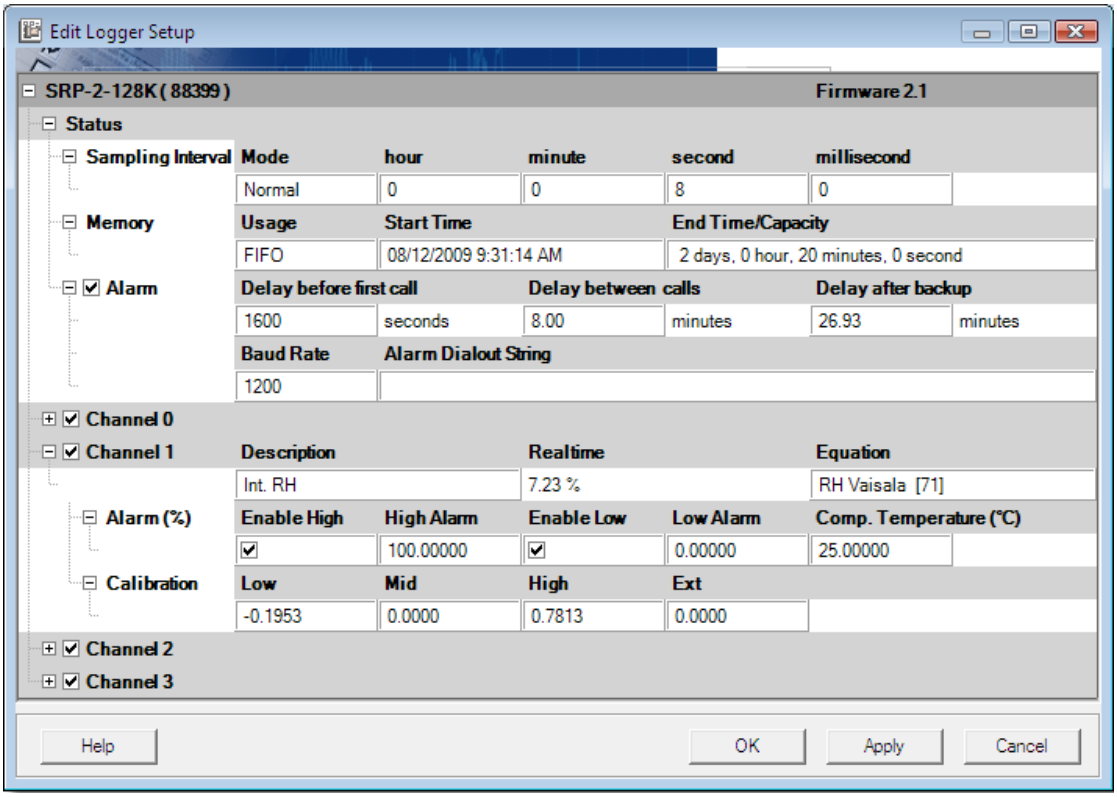
TrendReader software uses a software driver to communicate with SmartReader Plus data loggers. The software driver takes the form of two windows. The Status window, shown when you contact the logger, is used to display the settings currently stored in the data logger. The Setup window, shown when you select Edit Setup, is used to alter the current settings and apply the changes to the data logger. The settings are divided into two main sections: Status and Channels. Status contains information about sampling, memory and alarms. Each channel of the logger contains information about the description, equation and Realtime value, alarms, and calibration associated with the channel. You can control the level of detail that you see for the settings by clicking on the "+" and "-" buttons at the left side to expand and collapse the nodes.



When you want to clear the logger's memory and start a new logging session with new parameters, select **Edit Setup** from TrendReader. In the Edit Logger Setup window, make any necessary changes. To implement your changes, you can either click on **Apply** or **OK**. OK will implement the changes and close the window whereas Apply will leave the window

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

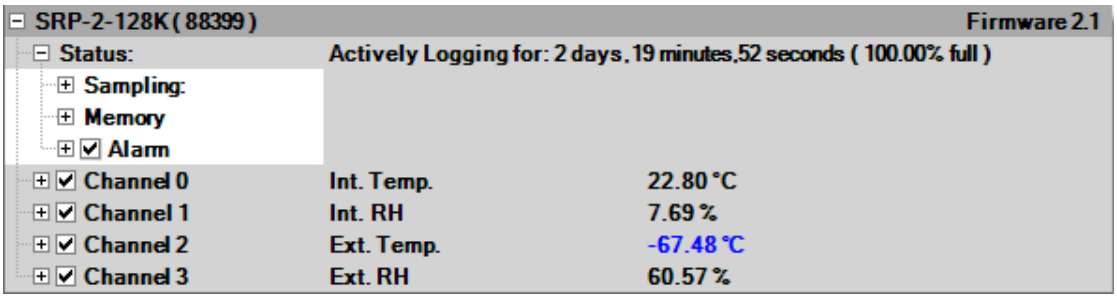
open, thereby allowing you to make changes in other features.



NOTE: SmartReader Plus data loggers can be connected together in a network. For information on networks, see Appendix F Connecting Multiple Loggers.

1.2.1 Logger Status

When you contact the logger, the logger status is displayed. The Status line indicates whether the data logger is actively logging, waiting to start or dormant. If you set up the logger with no delay, it will immediately start logging and the status will show the number of readings, or samples, that have been taken. If you want to have the logger wait before it starts logging, set the start time accordingly. The Status subsections are Sampling, Memory, and Alarms.

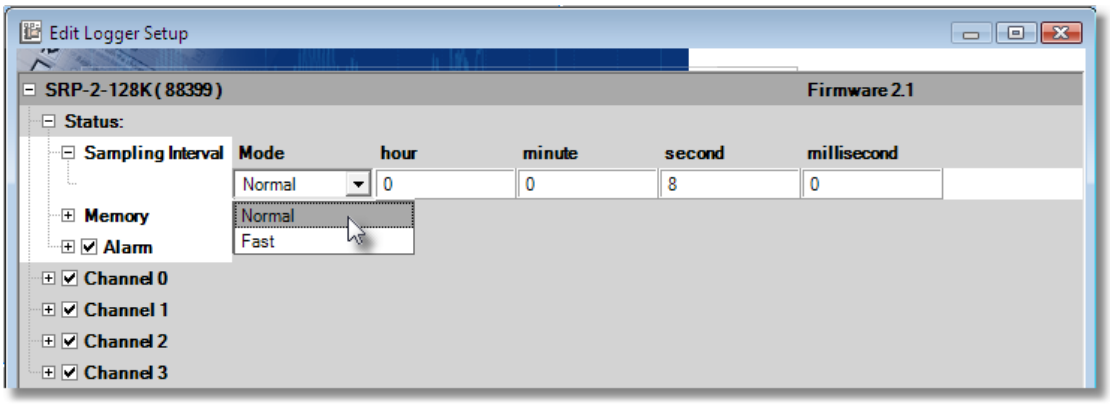


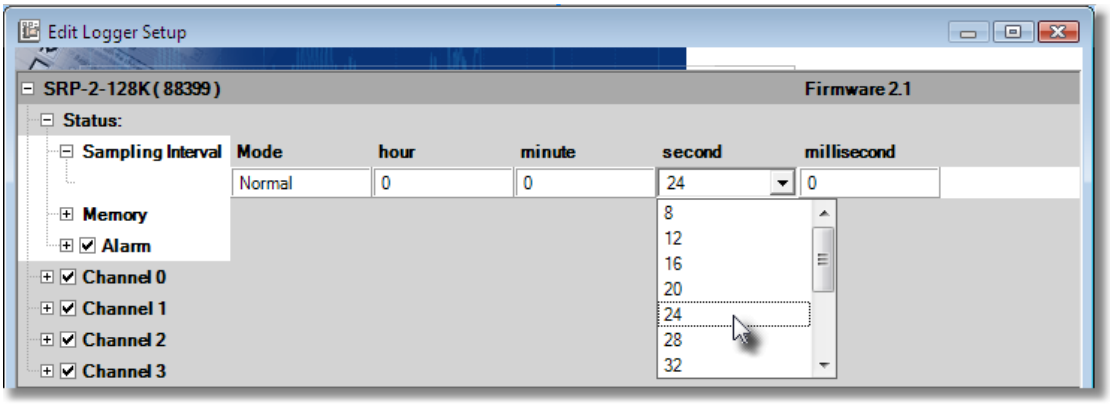
Copyright © 2010 ACR Systems Inc. All Rights Reserved.

1.2.1.1 Logger Sampling

The sample rate is the frequency with which a logger takes readings. The Sampling subsection indicates if the data logger is performing in a regular or fast sampling mode and what the sample rate is. In normal sampling, the rates available are from once every 8 seconds to once every 8 hours, while in fast sampling, the rates can be as quick as 25 times per second.

To set the logger for regular sampling, click on the Mode field and select Normal. To set the sample rate, click on the desired time unit and select the value from the drop-down list as shown. Note that millisecond sample rates are only applicable with fast sampling.





To find out more about sample rates and to view a set of sample rate tables, see Appendix E Sample Rates.

1.2.1.1.1 Fast Sampling

With the fast sampling mode, you can select sample rates from 0.04 seconds (25 readings per second) to 2 minutes. An external power source, such as an active computer communications port, power supply or battery pack, is required to operate the logger. The only memory mode available is "Stop When Full".

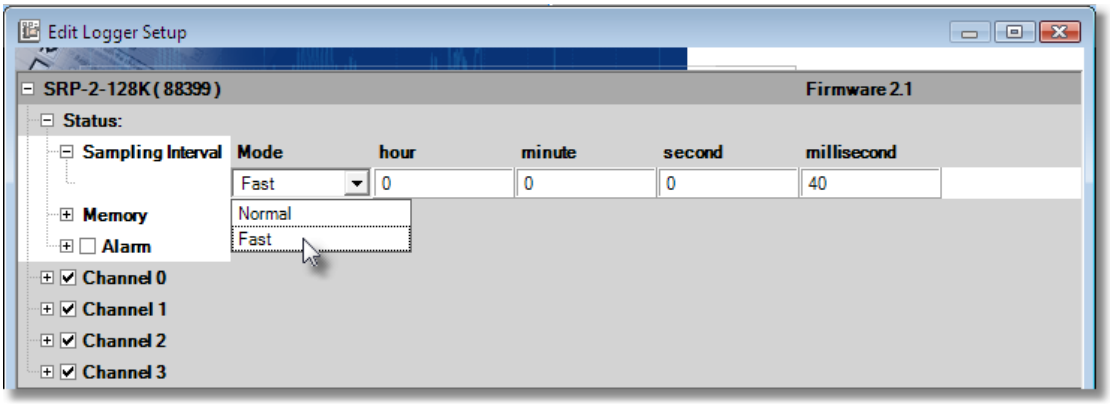
Copyright © 2010 ACR Systems Inc. All Rights Reserved.

***Note that the logger will stop recording (go dormant) when you communicate with it. Therefore, if you want to perform fast sampling with the logger connected to your computer, you need to turn off Realtime**.

To ensure that the logger takes data at the correct time, it is best to use the delayed start feature. The logger will begin to take readings when you connect the power source, providing the start delay has expired. Otherwise, the logger will start when the start delay times out if it has external power applied to it prior to the timing out of the start delay. Therefore, you need to set the start delay long enough for you to have time to save the setup and, if necessary, disconnect the logger and connect the battery pack or power supply. If you disconnect the logger, first set a delay of at least 16 seconds, then disconnect the logger within 8 seconds for proper operation.

When you are using sample rates as short as 0.04 seconds, you can run out of logger memory very quickly (two active channels at 0.04 seconds gives you 7 minutes and 10 seconds of memory). It is important that you do not waste any logger memory by starting the logger too soon or by leaving unused channels active.

To set the logger for fast sampling, click on the Mode field and select Fast. Next, click on the desired time unit and select the value from the drop down list.



1.2.1.2 Logger Memory

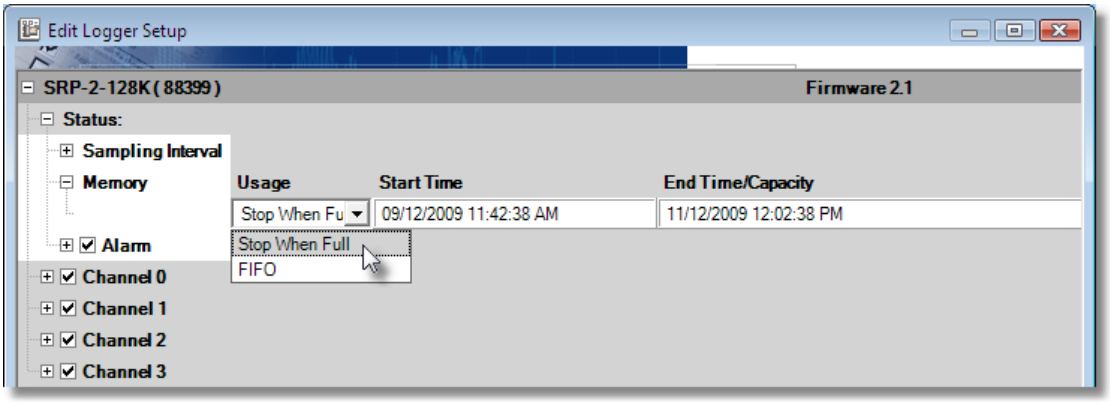
The Memory subsection indicates how the data is stored in memory and what the start and end times (or capacity) are for the data logging. In the FIFO (First In, First Out) mode, the logger continually stores data and when the memory limit is reached, the new readings start to overwrite the oldest readings. In this method, the logger is always collecting data, but only saves the most recent data in its memory. In the Stop When Full mode, when the memory limit is reached, the logger stops recording.

The capacity, or length of time for data capture of the logger is determined by the logger model, the number of active channels, and the sampling rate. Loggers come in 3 memory models: 32KB, 128KB, and 1.5MB. (If you want, you can choose to use only a portion of the available memory when you select the end time for the data capture). To find out more about how the capacity is affected by the sample rate and active channels, see Appendix E Sample Rates.

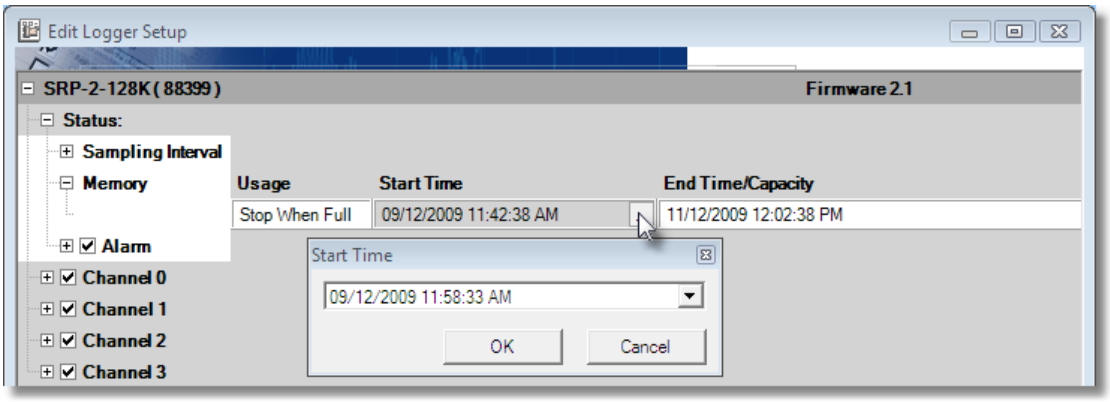
To set how the logger stores its data, click on the Usage field and select FIFO or Stop When

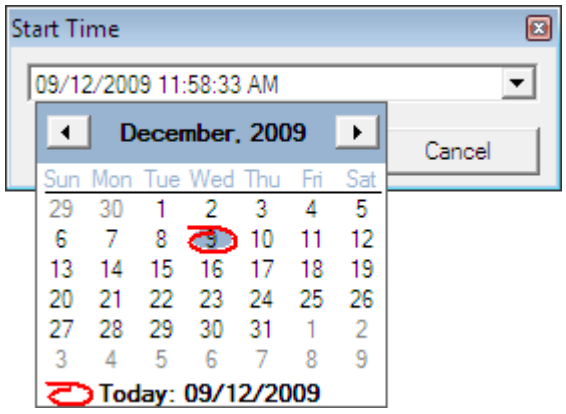
Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Full.



To set when the logger will start recording click on the Start Time field. Next, click on the small button that appears at the right. This will pop up a form allowing you to set the date and time. Highlight the date or time and enter the appropriate value. You can also click on the drop-down list arrow to bring up a calendar. You can set the logger's starting time for up to 6 days, 1 hour, and 39 minutes ahead.

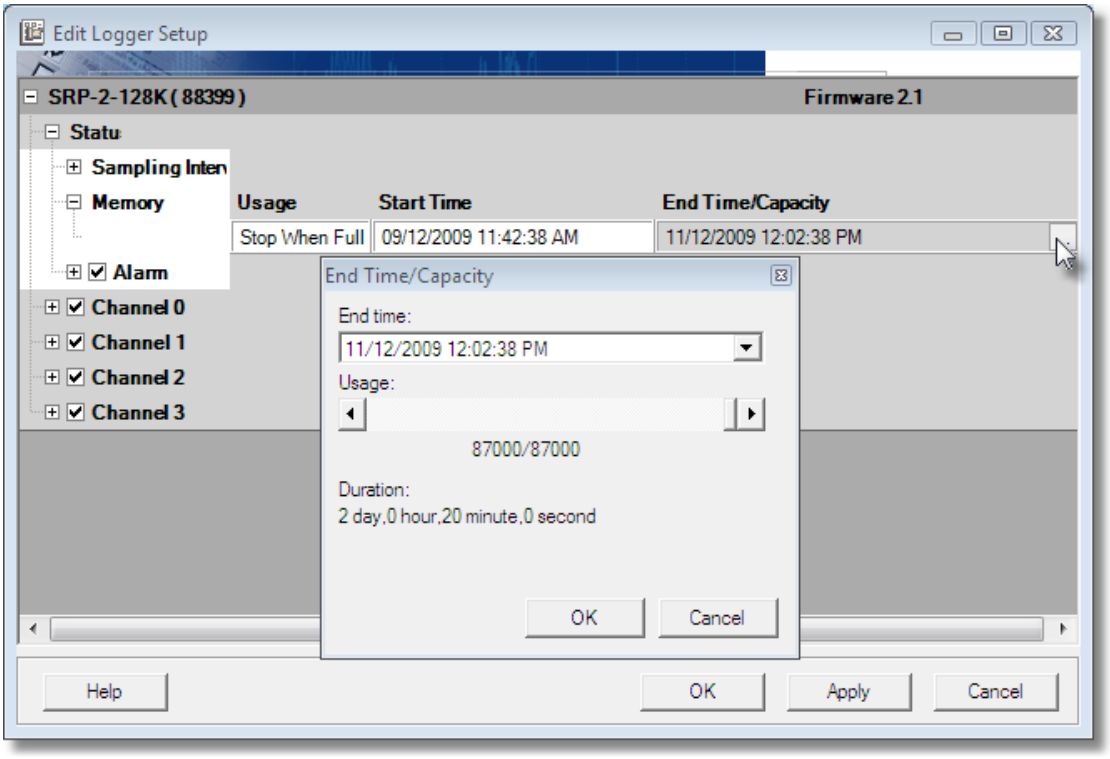


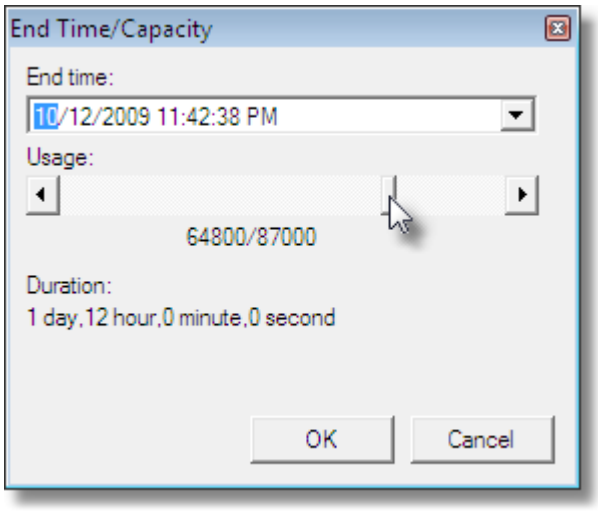


To set how long to record, click on the End Time field. Next, click on the small button that

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

appears at the right. This will pop up a form allowing you to set the date and time or the capacity. Just like entering the start time, you can highlight the date or time and enter the appropriate value or you can also click on the drop-down list arrow to bring up a calendar. If you want to record a specific number of readings, simply drag the usage bar to adjust the number of readings to take.





Copyright © 2010 ACR Systems Inc. All Rights Reserved.

1.2.1.3 Logger Alarms

Alarms are used to indicate when any reading has exceeded preset alarm thresholds. When an alarm condition occurs, the logger dials the stored number, typically for a phone or a pager, and leaves the remote site's phone number as a message. As such, alarms are very useful for monitoring loggers installed at remote locations. Note that alarms must be enabled for each channel that is monitored. Other than a modem, no special equipment is needed for Alarm Dialout. See the TrendReader guide for information on how to set up a modem at a remote site.

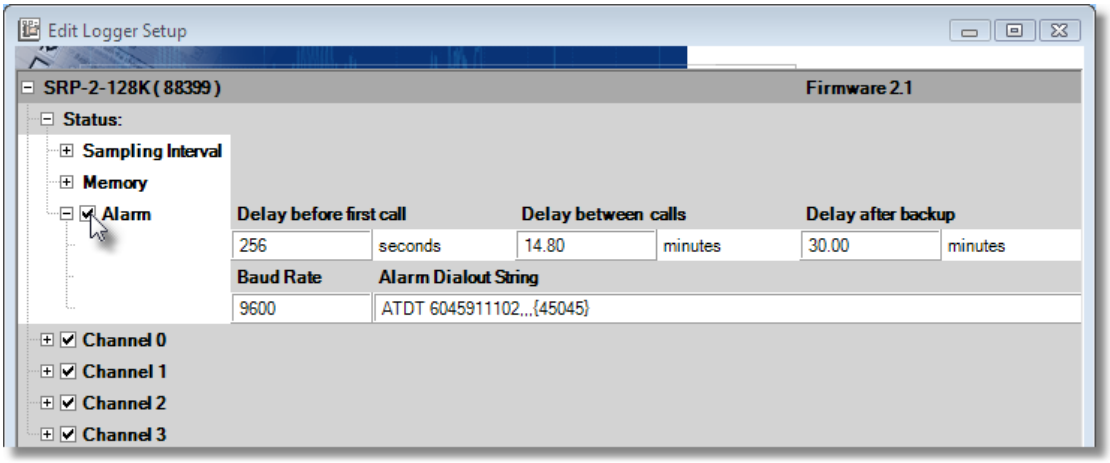
If the remote logger will be dialing a telephone number, the receiving telephone will need to have caller ID in order to display the remote site's number since a voice message is not left. When you see that the remote site has called, you can call the site to find out which logger caused the alarm.

If the remote logger will be dialing a pager, you can include a code, such as the logger's serial number, along with the phone number. This helps to identify which logger initiated the alarm call. However, in order to be able to do this, you must choose a pager system that accepts touch-tone codes that can be displayed on the pager. Since there can be many loggers on a network, being able to identify the logger that initiated the alarm can save quite a bit of time.

To respond to an alarm, you first need to dial into the site and back up the logger. Next, fix the problem that caused the alarm. Finally, reactivate the alarm by clearing the logger. As a precaution, you should regularly test the alarm system to ensure that if an alarm is triggered, the logger will dial the correct phone number.

To prevent false dialing, there is a delay after the logger is setup before alarms become enabled. Note that alarms do not operate in the fast sampling mode. If you enable alarms, fast sample mode is disabled. Alternatively, if you enable fast sampling, the alarms are disabled.

The alarm parameters are discussed in the following sections. In order to set any of the alarm parameters, alarms must first be enabled.



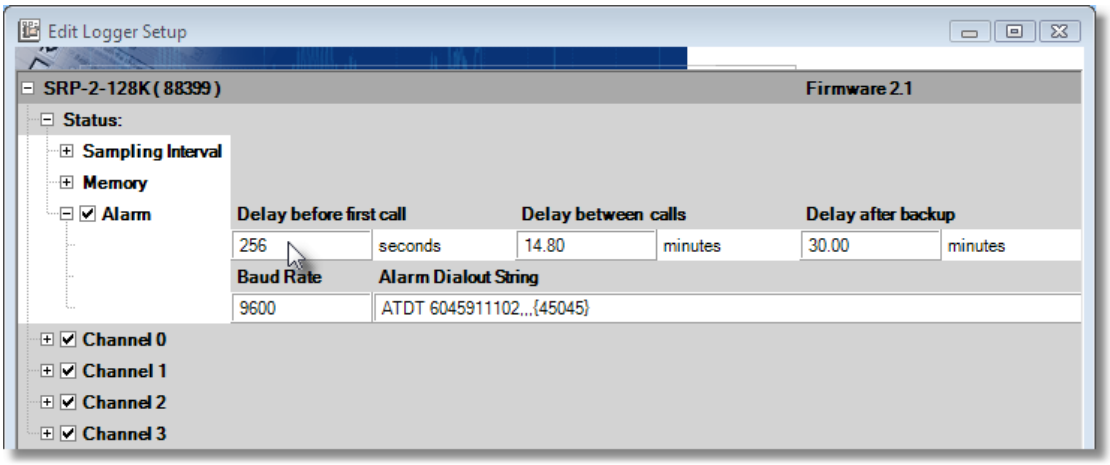
Copyright © 2010 ACR Systems Inc. All Rights Reserved.

1.2.1.3.1 Delay Before First Call

The Delay Before the First Call is the length of time that a logger will wait before dialing out once an alarm condition has occurred. If you do not want the remote logger to dial out immediately when one or more of its channels go into an alarm condition, you can set the Call Delay to designate the number of seconds the logger has to wait before dialing. The maximum time for this delay is 2040 seconds.

The alarm condition must exist for the entire delay time, otherwise the logger will not dial out. If the logger comes out of an alarm condition during the call delay period, the delay timer will stop and will start again from zero at the next alarm event. This is useful in limiting temporary or false alarm triggering.

To set this delay, click on the Delay Before First Call field and enter the value.

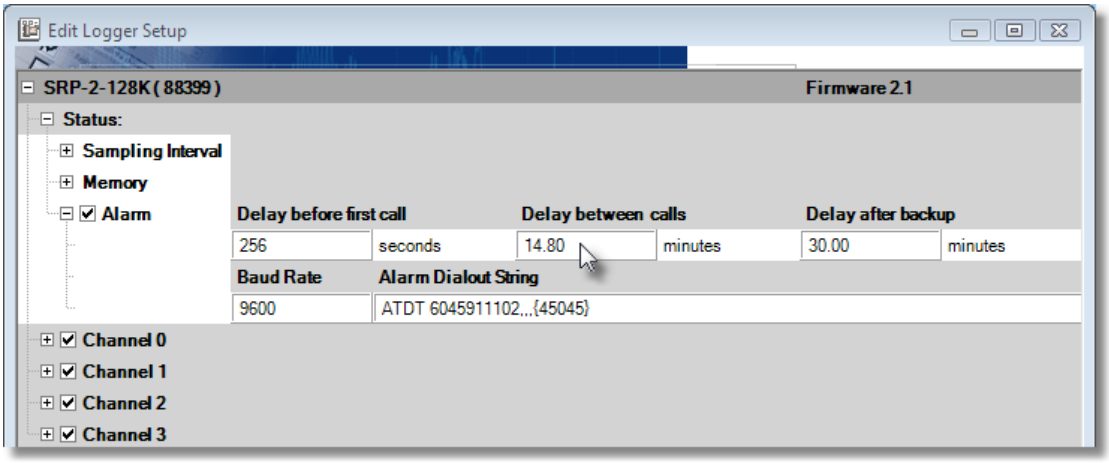


1.2.1.3.2 Delay Between Calls

The Delay Between Calls is the time between successive calls. A logger will continue to dial out after every delay period as long as an alarm condition exists and has not been acknowledged by backing up the logger.

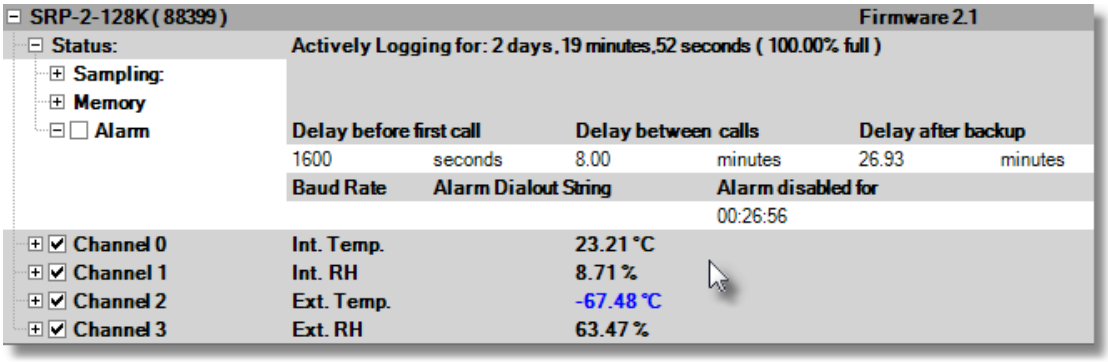
Copyright © 2010 ACR Systems Inc. All Rights Reserved.

To set this delay, click on the Delay Between Calls field and enter the value.



1.2.1.3.3 Delay After Backup

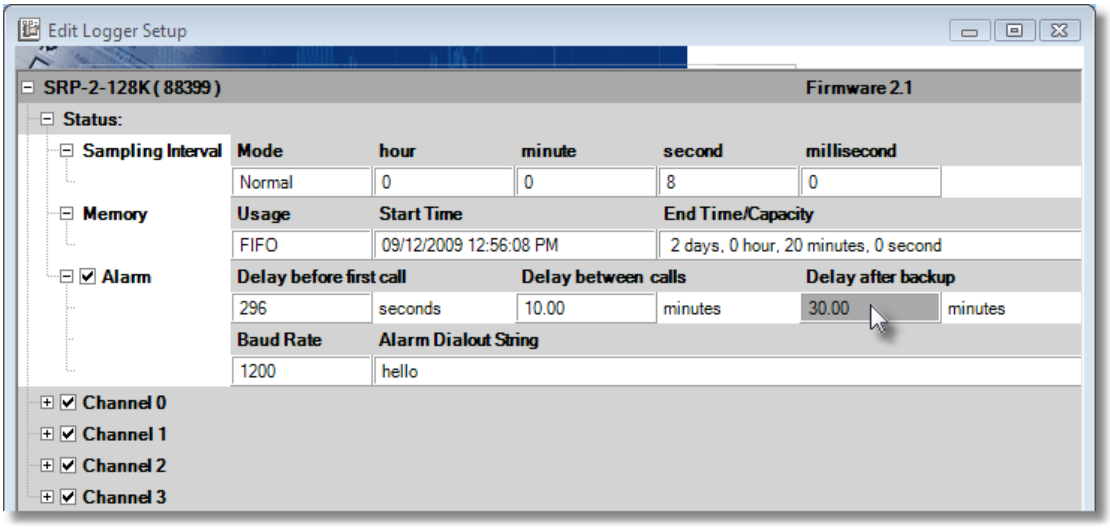
The Delay After Backup is the period of time that the alarm feature is temporarily disabled after the logger has been backed up. The delay begins when you acknowledge the alarm by backing up the logger that dialed out. The Delay After Backup deactivates the alarm, giving you time to fix the problem that caused the alarm. The maximum delay is 720 minutes. When you look at the logger status window (not in Edit Logger Setup) you will see the time counted down. Note that the time shown may be slightly inaccurate if you Realtime the logger.



If the delay period elapses and the alarm condition still exists, the logger will dial out again. To bypass the Delay After Backup period (if you have fixed the alarm problem but there is time remaining on the delay which is preventing the alarm from being activated), you can clear the logger to clear this delay.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

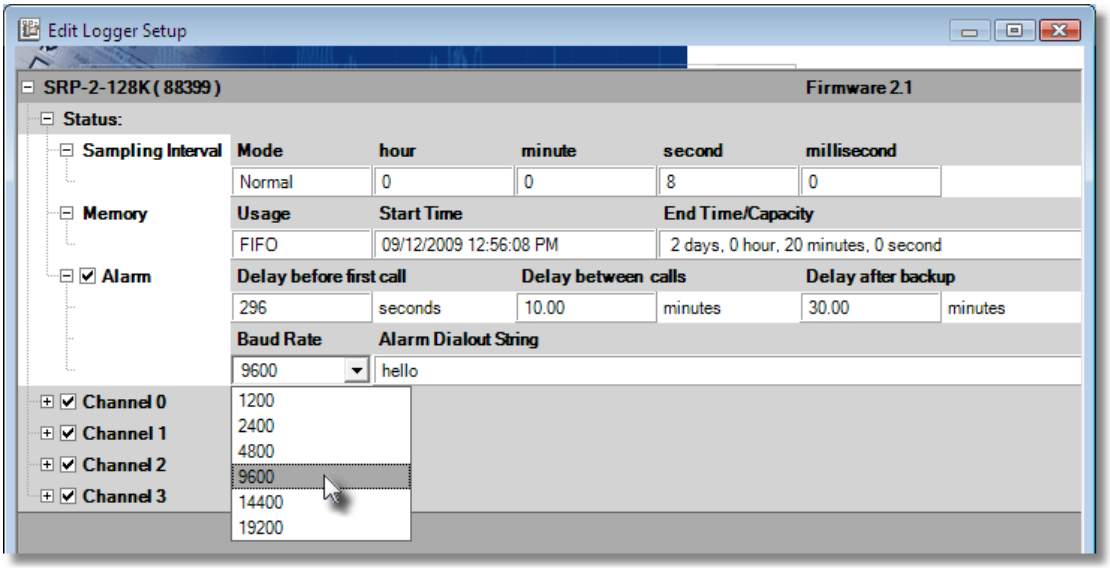
To set this delay, click on the Delay After Backup field and enter the value.



1.2.1.3.4 Baud Rate

The Baud Rate determines the data rate that the logger uses to communicate with the modem that performs the dialing out. The baud rates available range from 1200 to 57,600.

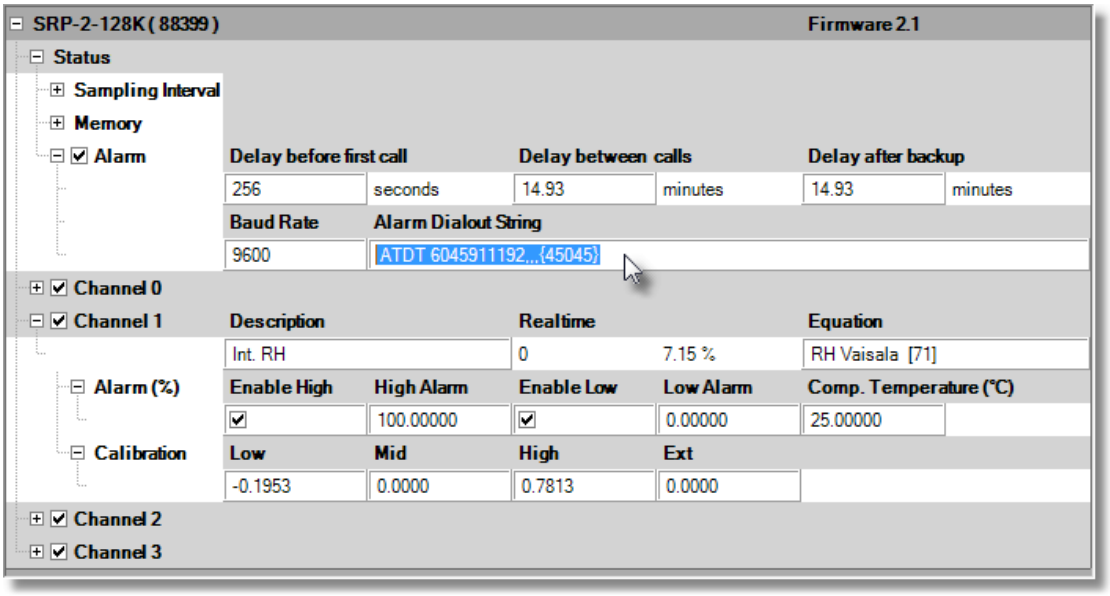
To set the baud rate, click on the Baud Rate field and select the value from the drop-down list.



Copyright © 2010 ACR Systems Inc. All Rights Reserved.

1.2.1.3.5 Alarm Dialout String

The Alarm Dialout String contains the phone number to dial, along with any modem commands or messages. To set this string, click on the Alarm Dialout String field and enter the value.



Calling a Telephone

Remember that the telephone receiving the alarm call must have caller ID to display the remote site's phone number, otherwise you will have no way of knowing where the call came from.

1. The first part of the string contains a *dial command* for the modem. If the phone line at the remote site has tone dial, type ATDT. If the phone line has plus dial, type ATDP.

2. After the dial command, type the number of the telephone that is to receive the alarm call.

For example, if you wanted a logger to dial a number from a tone dial phone line you would type: ATDT 123-555-2222

Calling a Pager

In order to include a code that will identify the logger that called the phone number, you must choose a pager system *that accepts touch-tone codes that can be displayed on the pager.*

1. First type the modem's *dial command* ATDT.

2. After the dial command, type the number of the pager that is to receive the alarm call.

3. After the pager number and before the identifying code, there must be a pause to allow the receiving station to answer. Enter this pause by typing commas. (For most modems each comma causes a pause of two seconds).

4. Type a code that will identify the logger.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

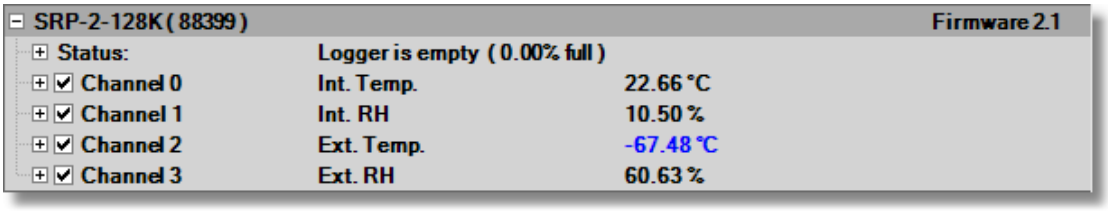
For example, if you want to dial a pager number, pause for several seconds, and then send the serial number of the data logger, you would type: ATDT 123-555-2222,,,,,12345

1.2.2 Logger Channels

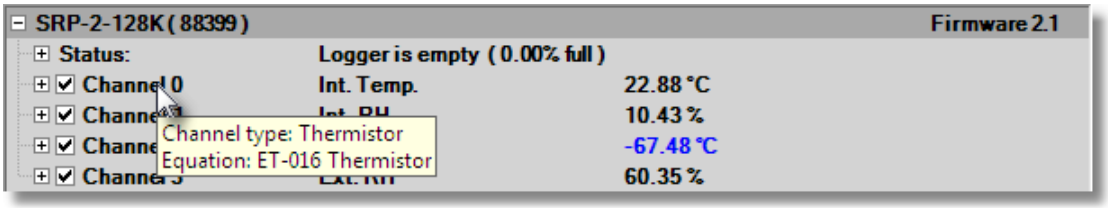
The Channels section indicates what channels are enabled (there is a check mark beside the channel number) and provides information specific to each channel. When you enable a channel on a logger, it becomes an active channel and it continually records readings and stores them in the logger's memory. You should disable any channels you are not using so that there is as much memory as possible available for the active channel(s). The Channel subsections are Information, Alarms, and Calibration.

1.2.2.1 Channel Information

When you contact the logger, the logger status is displayed. The Channel line gives the description and the Realtime value, if Realtime is turned on. The Realtime value is based on the equation that you select for the channel.



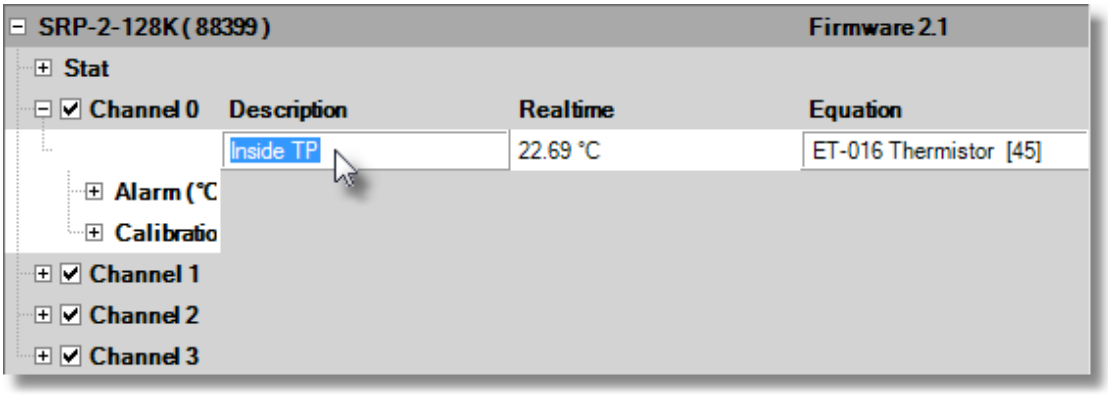
The equation is selected in the Setup window but is shown in the Status window only as a tool-tip. To see the equation point your cursor over the channel and it will show the channel type and equation.



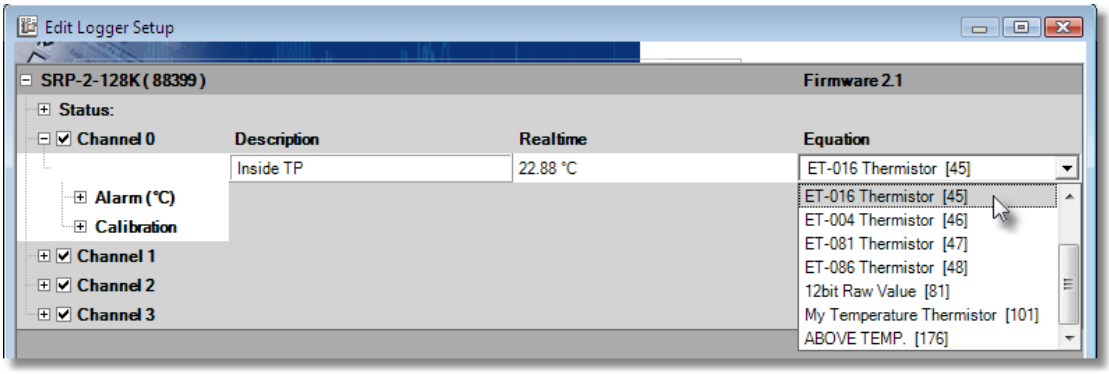
In the Setup window, a channel type tool-tip is displayed when the cursor is pointed over a channel.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

To set the description, click on the Description field and enter the name.



The logger collects and stores raw data readings. An equation is used to transform the raw data into measurement units, such as °C, with the current reading shown as a Realtime value. You can use built-in equations or you can create your own custom equations. See Equations in the TrendReader guide for further information. To set the equation, click on the Equation field and select the equation from the drop-down list. To help you select the proper equation, the Realtime value using the currently selected equation is shown. *



Some channels compensate their output by using the value of another channel. For example, the calculated value for an RH channel depends on the reading of the RH sensor and the value of the temperature channel. In such cases, the compensation channel must output in the correct units. In the case of RH, for example, the temperature channel must output in units of temperature. Using units of byte counts, switch status, or resistance will give invalid results.

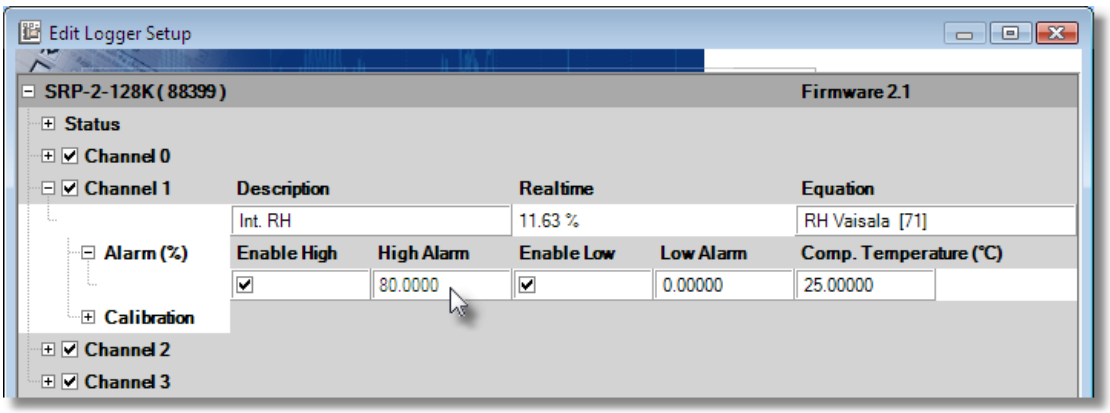
* Note that if a custom equation is not available when Edit Setup... is selected (e.g.: deleted) then the equation will be shown as unknown. If a new equation is not selected the Realtime value will not display correctly. If the logger is backed up the channel will be disabled then changes to the equation can be made in the graph using the Lines Tab in Graph Settings.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

1.2.2.2 Channel Alarms

The Alarm subsection shows the high and low alarm thresholds and whether the high and low alarms are enabled. See Logger Alarms for a description of the logger alarms. To set each alarm, first enable the alarm, then click on the Alarm field and enter the value.

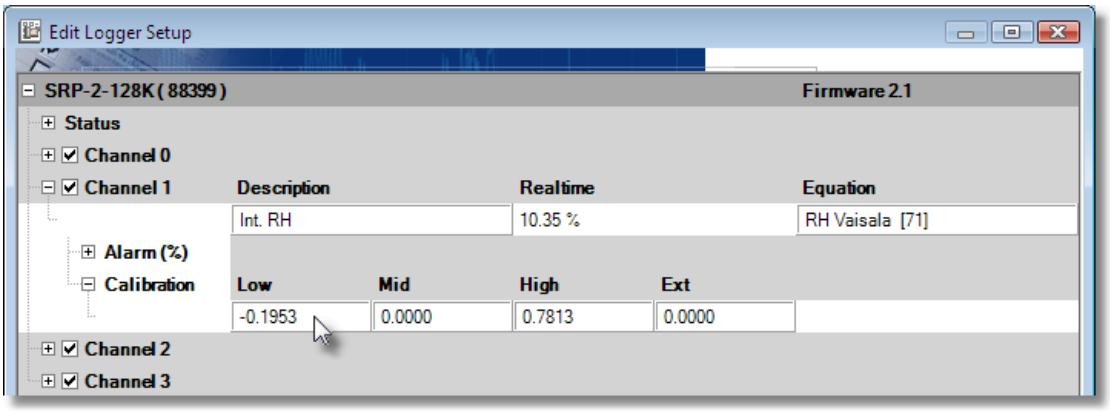
For some channels, such as RH, the sensor output depends on the temperature and the equation needs to compensate for this. When setting the alarms, you also need to enter the expected operating temperature in the Comp. Temperature field.



Note that the default high and low alarm values will be displayed when the alarms are enabled. When you enter alarm values between the high and low range the enabled alarms be saved upon Apply or closing the window.

1.2.2.3 Channel Calibration

The Calibration subsection shows the Low, Mid, High, and Ext calibration values. These values are used to adjust the readings of the logger in order to make the output more accurate. To set each calibration value, click on the appropriate calibration field and enter the value.



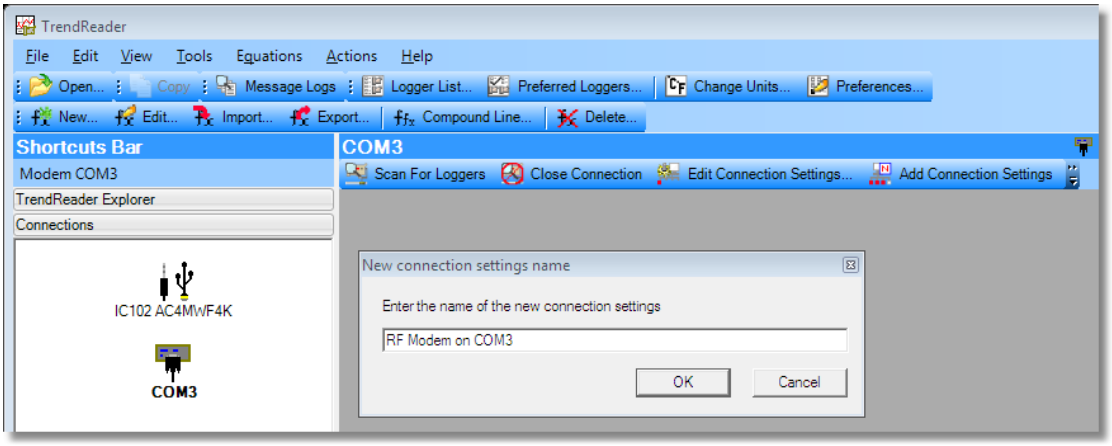
Copyright © 2010 ACR Systems Inc. All Rights Reserved.

1.2.3 Logger Connection Settings

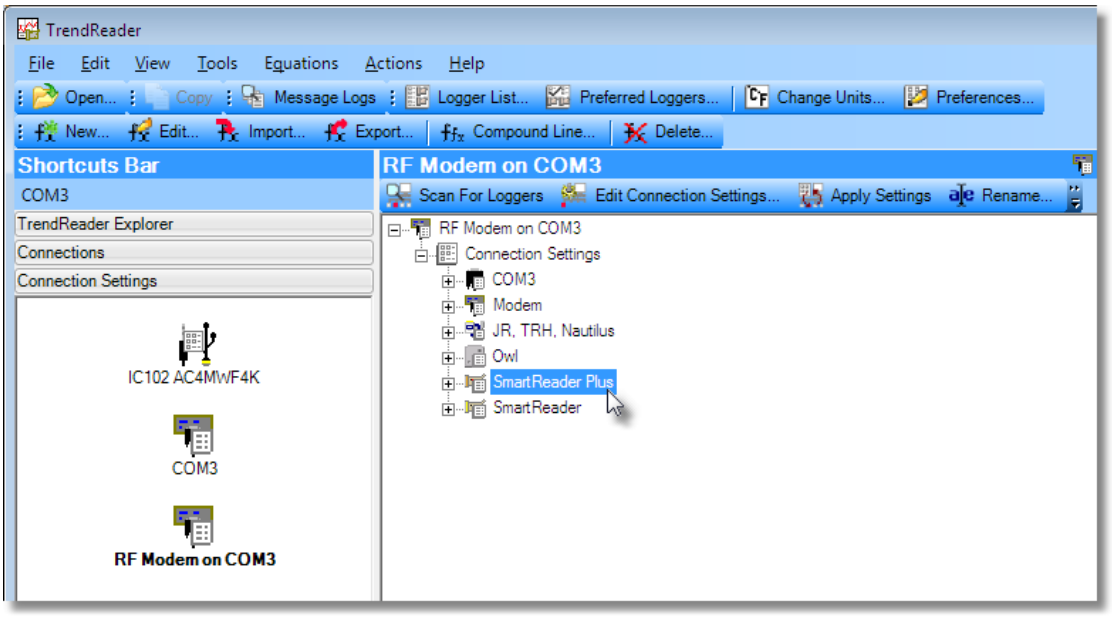
If you are using a wireless or RF modem, with an RFA adapter cable, then you will have to change the Cable type and possibly the Block size.

Cable Type

1. If you have not yet saved a connection setting for the RF modem, select the Connections view in the Shortcuts Bar of TrendReader. Otherwise skip to step 4.
2. Select the COM port to which the RF modem is attached.
3. Click **Add Connection Settings** and enter in the name of the connection setting.

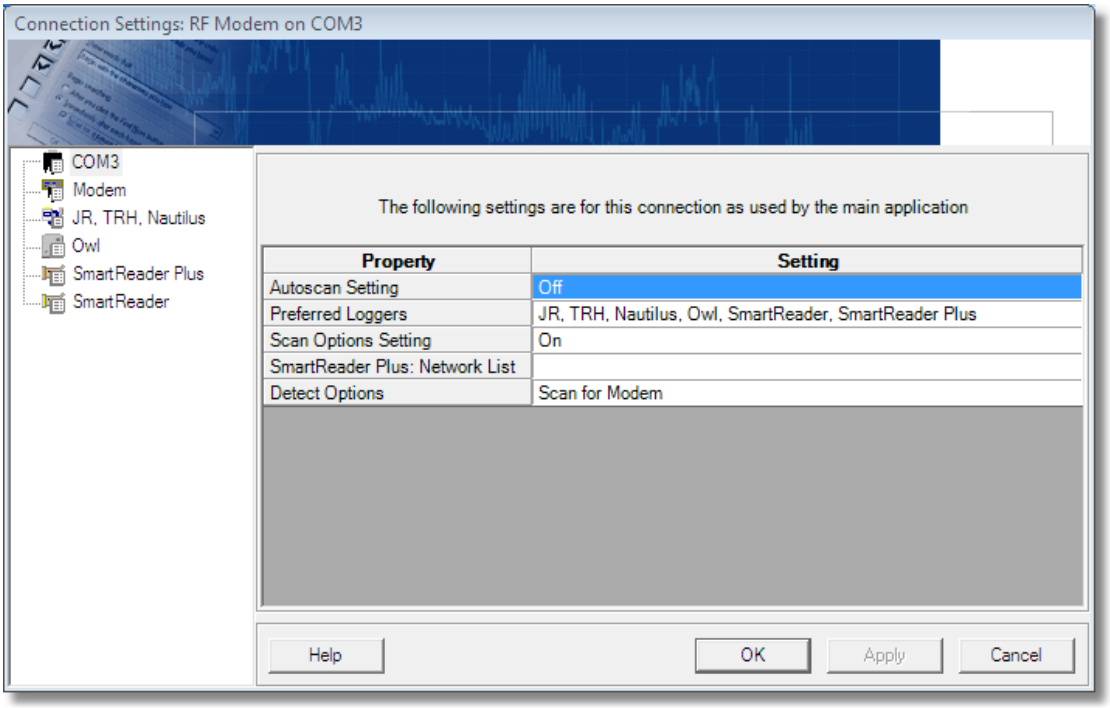


4. Select the Connection Settings view in the Shortcuts Bar of TrendReader.
5. Select the RF modem connection setting.
6. Click **Edit Connection Settings** to bring up the connection settings dialog box.



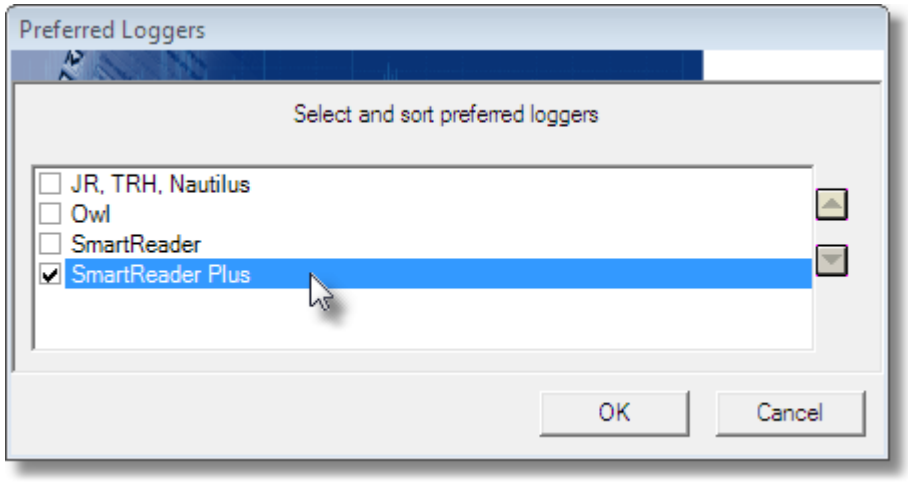
7. Click on the Preferred Loggers field to pop up the Preferred Loggers form.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

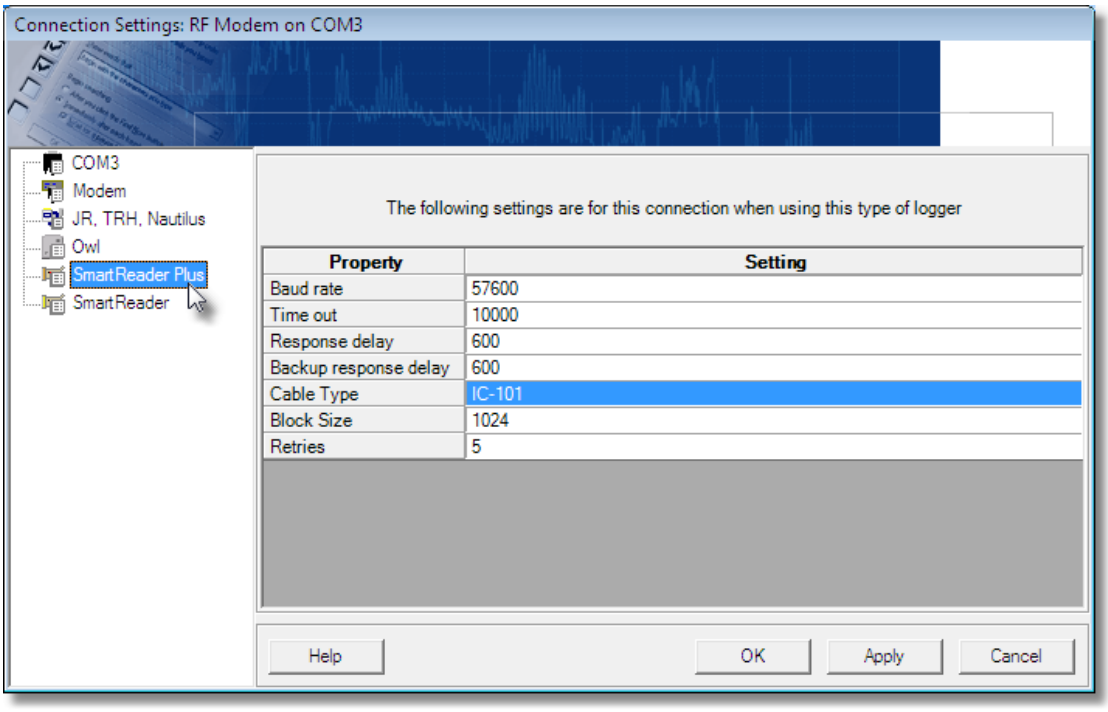


8. Select only the SRPLogger. Click **OK**.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.



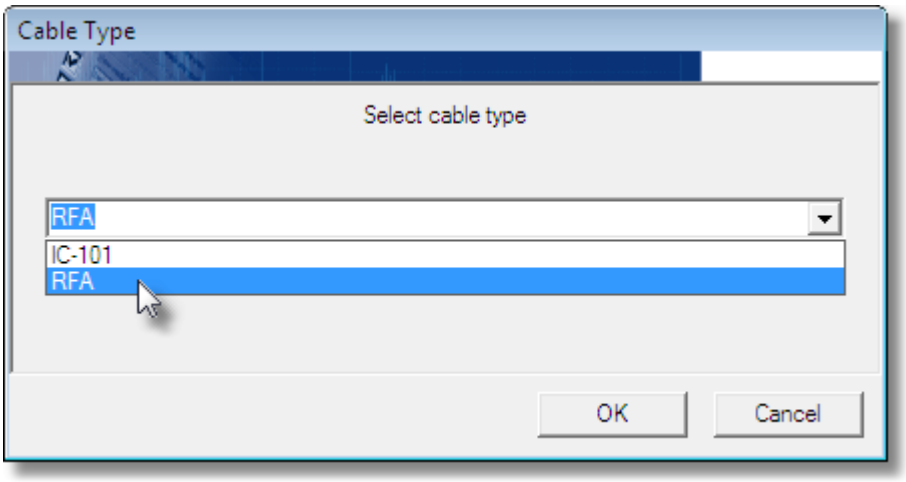
9. Click on the **SRPLogger** node.



10. Click on the **Cable Type** field to pop up the Cable Type form and select the RFA cable.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

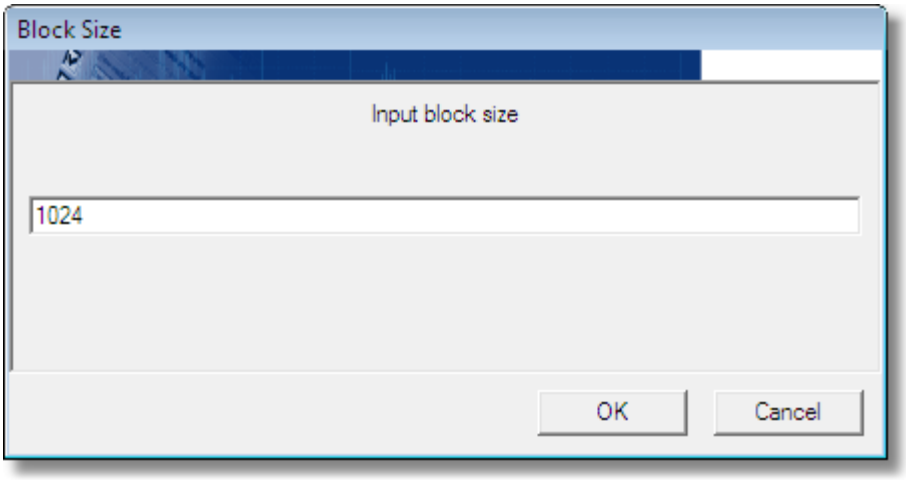
Click **OK**.



Block Size
The Block size you use depends on the buffer size of your modem minus the overhead of the logger, which is 14. For example, if your RF modem has a block size of 256, then a reasonable value for the Block size would be 240.

11. Click on the **Block Size** field to pop up the Block Size form and enter in the value. Click **OK**.

You may have to experiment with the Block size to maximize throughput since smaller block sizes transmit less data but usually have fewer retries.



Copyright © 2010 ACR Systems Inc. All Rights Reserved.

1.3 SmartReader Plus 1 Temperature Logger

The SmartReader Plus 1 is an easy-to-use logger for recording temperature in a wide range of applications such as HVAC testing/balancing, property management studies, and transportation of perishable goods.

Figure 1-1: SmartReader Plus 1

1.3.1 Description

The SmartReader Plus 1 has an on-board thermistor temperature sensor and an external temperature sensor channel for remote measurements with an optional probe.

1.3.2 Setup

Make sure to enable each channel you want to use. If you are not using a channel, disable it in order to save memory.

Channel	Description	Equation
0	Internal Temperature	45
2	External Temperature	Appendix C

Accessories
The SmartReader Plus 1 Temperature Logger can be used with ET series temperature probes (refer to Appendix C Thermistor Temperature Probes or any NTC thermistor data). To use an external temperature probe, simply connect the two wires to the terminals marked "**Temp. Sensor**" and activate the external temperature channel. Note, the polarity does not matter when connecting thermistor leads. If you are using shielded cable (recommended for cable extensions), terminate the shield wire by connecting it to the lower of the two "**Temp. Sensor**" terminals (the *common* terminal).

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Other Applications
For information on how you can monitor resistance or switch status with your SmartReader Plus 1, refer to Appendix A Monitoring Resistance and Switch Status.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.4 SmartReader Plus 2 Temperature & Relative Humidity Logger

A self-contained "air-quality" logger, the SmartReader Plus 2 can be used easily in a wide variety of applications to collect temperature and relative humidity data.

Figure 2-1: SmartReader Plus 2

1.4.1 Description

The SmartReader Plus 2 includes an on-board thermistor temperature sensor and a plug-in RH Sensor plus two input channels for an optional remote temperature and relative humidity probe.

How It Works

The relative humidity sensor in the SmartReader Plus 2 is a processed plastic wafer. This wafer is actually a laser-trimmed, capacitive thin-film relative humidity sensor.

Changes in relative humidity cause the surface capacitance of the polymer film to vary. The SmartReader Plus 2 gauges this capacitance by passing a small electric current through it and measuring the relative voltage drop. Because the response of the sensor is temperature dependent, a temperature reading is always taken at the same time as the humidity reading. That way, when the logger's information is backed up into your computer, TrendReader software can automatically factor in the right compensation values when it calculates the percentage of Relative Humidity (in % RH). The result is an accurate set of automatically-generated and temperature-compensated relative humidity readings.

1.4.2 Setup

Make sure to enable each channel you want to use. If you are not using a channel, disable it in order to save memory.

Channel	Description	Equation

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

0	Internal Temperature	45
1	Internal Relative Humidity	71
2	External Temperature	Appendix C
3	External Relative Humidity	71

NOTE: When you activate either RH channel, you must also enable its corresponding temperature channel, as well, in order to temperature compensate the RH sensors.

Precautions
The SmartReader Plus 2's RH Sensor is designed for long-term trouble-free performance, but there are a few precautions to keep in mind to maximize the benefit it can give you.

- Never expose the sensor to organic solvents or ionic-laden liquids. Any chemical compound that attracts polymers may affect the sensor.
- The RH sensor is particularly susceptible to contamination by sulfur gases and sulfur compounds. **DO NOT SMOKE NEAR THE LOGGER!**
- Always return your SmartReader Plus 2 to a re-sealable plastic bag during non-use to maximize the in-calibration life of the RH sensor.

1.4.3 Accessories

You can obtain replacement RH Sensors, remote temperature probes, temperature and relative humidity probes for use with your SmartReader Plus 2.

ET Series Temperature Sensors
The ET series of temperature sensors are thermistor probes that can be used easily with your SmartReader Plus 2 for remote temperature measurements. The advantage of these probes is that they can be used for a wide range of temperatures, are more versatile (they can be used to record fluid temperatures) and their small size permits them to be easily inserted into hard-to-get-at-locations (such as in ductwork or under pipe insulation).

To use an ET temperature probe with your SmartReader Plus 2 you must first enable the logger's external temperature channel. Connect the remote temperature probe by attaching one wire (of the two wire probe) to the channel marked **Temperature** and the other wire to the terminal marked **Common**. For more information on ET series thermistor probes, refer to: Appendix C Thermistor Temperature Probes.

EH-020A Temperature and Relative Humidity Probe
The EH-020A is a four-wire probe with a temperature and relative humidity sensor. For field-mounting convenience, it also has a magnetic backing and a security eyelet. To use the EH-020A with your SmartReader Plus 2, you must enable the logger's external temperature and humidity channels. To connect the EH-020A probe to your SmartReader Plus 2, follow instruction notes packed with each RH probe set -- see Figure 2-2.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

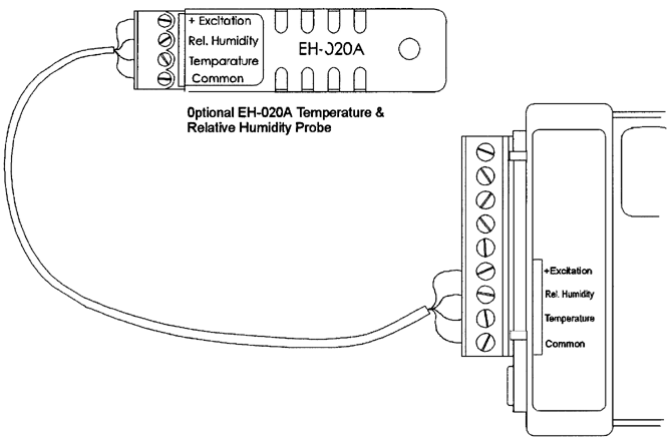


Figure 2-2: EH-020A Connection

The EH-020A is applicable for measurements between -20 and 40°C (-4 and 104°F) and 10 to 90% RH.

The accurate measurement of temperature and humidity depends primarily on the information supplied by a particular sensor. SmartReader Plus 2 data loggers use temperature and humidity sensors with rugged qualities designed for minimal or no maintenance (under normal operating conditions).

The SmartReader Plus 2's on-board thermistor is chemically stable and not significantly affected by aging. It will typically drift less than 0.1°C over a period of several years. The relative humidity sensor, although subject to accuracy degradation when exposed to contaminants and/or extreme environmental conditions, will drift typically less than 1% per year (under clean conditions). You should check your RH sensor periodically and, if necessary, recalibrate or replace it.

1.4.4 Troubleshooting

If you are getting what appear to be wrong readings, consider the following before recalibrating the sensors. Sensors sample the atmosphere (or medium) in the immediate vicinity of the sensors themselves. The physical state of the atmosphere and its degree of uniformity and turbulence will limit the validity of a measurement at some distance from the sensor. This becomes especially apparent for the measurement of ambient temperature and relative humidity.

In a room, temperature and RH levels may vary dramatically from location to location. Such factors as air stratification, drafts and proximity to heat or humidity sources (people, equipment, moisture, solar gain, etc.) can contribute to a wide variance in conditions even within a small confined area. The individual sensors associated with your SmartReader Plus 2 measure and record temperature and RH only in one location. They do not, in any way, represent an overall reading.

If you decide to check the calibration of your SmartReader Plus 2 RH sensor using a Sling Psychrometer, keep in mind the following:

- Any instrument that requires a person to be present at, or in very close proximity to the RH sensor in order to get a reading, will have a measurement error introduced to it.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

That is because the body readily gives off heat and moisture that is especially noticeable at lower RH levels.

- The time taken between slinging the psychrometer and reading it can exhibit several degrees of inaccuracy in the wet bulb reading. Air currents around the body, whether it is slung in the shade of a building or in sunlight, not knowing how to tie the wet sock, its condition, and the purity of water used, all contribute to error. In addition, interpolating the data from a psychrometric chart can add another 2 to 4% to the accumulative error.

1.4.5 Relative Humidity Calibration

Each relative humidity sensor has been individually calibrated in an environmental chamber with standards traceable to the National Institutes of Standards and Technology (NIST).

The SmartReader Plus 2 and the EH-020A probe are supplied with a calibration certificate which provides calibration values. These calibration values must be entered and stored in the logger during initial setup. If your RH sensor is out of calibration, you can simply replace it with a new one.

> **NOTE:** A straight replacement of the RH sensor will introduce an additional +2% tolerance on the RH accuracy. Calibration of the RH channel with the new RH sensor is recommended.

In the event that you wish to confirm the RH calibration of your sensor, you can perform your own field test. Refer to Appendix B Temperature and Relative Humidity Calibrations for more information on RH testing.

Interchangeable replacement RH sensors for loggers are available through your dealer. For best accuracy, it is recommended these be calibrated together with the logger - consult your ACR representative for price and availability of this service. Replacement EH-020A modules which are pre-calibrated are available through your dealer.

1.4.6 Specifications

Relative Humidity Sensor & EH-020A

Type:	Capacitive thin polymer film
Range:	0 to 95% (non-condensing)
Accuracy:	±3% RH from 10 to 90% (-20 to 40°C [-4 to 104°F])
Resolution:	Better than 0.04% between 25 and 60% RH at 25°C (77°F)
Response Time:	Adequate ventilation reduces the response time which is approximately five minutes in still air.
Environmental Conditions:	The RH sensor is relatively immune to chemical contamination but when exposed to extreme environmental conditions, accuracy degradation could result. For long-term stability and reliable readings, the sensor should not be subjected to liquid immersion or exposed to high concentrations of organic solvents, corrosive agents, sulfur gases and strong acids or bases. Dust settling on the sensor surface will not affect sensor performance except possibly to

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

decrease the speed of response.

Chemical Tolerances: Limits for different chemical groups

1. Organic solvents typically 1,000...10,000 ppm
2. Corrosive agents (strong acids S02, H2SO4, Cl2, HCl, H2S etc.) typically 1...10 ppm
3. Weak acids typically 100...1,000 ppm
4. Bases typically 10,000...100,000 ppm

Specifications are subject to change without notice.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.5 SmartReader Plus 3 Current, Voltage and Temperature Logger

The SmartReader Plus 3 is a versatile equipment performance logger. It monitors and records AC current and voltage.

Figure 3-1: SmartReader Plus 3

1.5.1 Description

The SmartReader Plus 3 has four current-monitoring channels, three 0-5 VDC inputs for connection to AC voltage transducers, and one internal thermistor temperature channel. The current-monitoring channels are used with external clamp-on-current probes to measure and record alternating current.

The following current probes from Amprobe Instruments are compatible with the SmartReader Plus 3:

- A60FL and A70FL for 60Hz power systems
- A65FL and A75FL for 50Hz operation

Use of these probes allows you to measure alternating current of conductors without the need for breaking circuitry. For information on current ranges and resolutions possible with the SmartReader Plus 3, refer to the Specifications in this chapter.

Current Channel Operation
The SmartReader Plus 3 measures electric current through external current probes. Each current probe is a transformer with its internal coil serving as the secondary winding and the current-carrying conductor being measured serving as the primary winding. The output of the probe (which is the input to the SmartReader Plus 3) is conditioned through internal circuitry. The probe produces an output of approximately 260 microamps full scale for each range available on the current probe. Readings from the current probe are scaled into amperage units through equations (in TrendReader software) that match the current probe and its range setting.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.5.2 Setup to Measure Current

The procedure for setting up your SmartReader Plus 3 is as follows:

1. Connect one or more current probes, specified above, to the current channel inputs on your SmartReader Plus 3. Make sure to observe polarity when making connections. Connect the current probe's red (**+**) wire to the channel's "**+ Red**" input. Connect the current probe's black wire to the channel's "**- Black**" input.

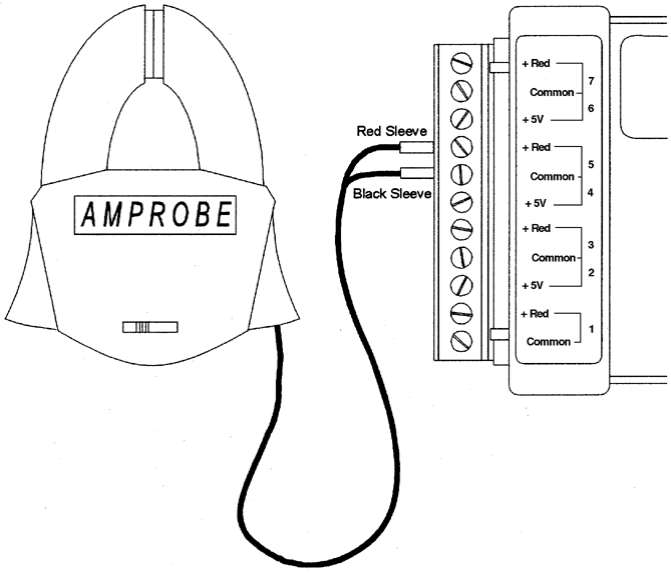


Figure 3-2: Current Probe Connection

2. Adjust the range setting on the current probe(s) to suit your application. A good way to verify a conductor's maximum range is to check the circuit breaker or fuse rating. Set the range on your current probe to suit. Since the probes do not give predictable readings below 10% in any range, always choose the lowest range possible to encompass the full range of data you want to record.

3. Make sure to enable each channel you want to use. If you are not using a channel, disable it in order to save memory.

Channel	Description	Equation
0	Internal Temperature	45
1	Current 1	64
2	5 Volt DC	18
3	Current 2	64
4	5 Volt DC	18
5	Current 3	64
6	5 Volt DC	18

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

7	Current 4	64

	A60FL / A65FL	
Switch	**Range**	**Equation**
5	0.5 to 5 A	63
25	2.5 to 25 A	64
100	10 to 100 A	65
250	25 to 250 A	66

	A70FL / A75FL	
Switch	**Range**	**Equation**
10	1 to 10 A	67
50	5 to 50 A	68
250	25 to 250 A	69
500	50 to 500 A	70

Precautions

1. **DANGER: High voltage may be present!** Do not clamp a current probe around a conductor without the logger connected to it. This avoids sparking and prevents the connectors from prematurely deteriorating.

2. The SmartReader Plus 3 is to be used only with approved current probes from Amprobe Instruments (A60FL, A70FL, A65FL and A75FL). These probes provide low voltage DC current in proportion to the signal being measured. DO NOT use any other probe unless approved by ACR in writing.

3. The SmartReader Plus 3 can record current in accordance with the ranges available on the A60FL, A65FL, A70FL and A75FL probes. Always make sure the current you will be recording will fall into the appropriate range you set on the current probe.

1.5.3 Voltage Channels

The SmartReader Plus 3 is equipped with three 0-5V DC voltage channels. These channels allow the user to monitor 3-phase AC voltage. AC voltage is monitored by connecting AC voltage transducers to the 5V channels.
(See Appendix D Typical SmartReader Plus 3 Connection Diagram for more information).
These transducers will provide a DC output proportional to the AC input. The equation editor in TrendReader software allows displaying this in units of AC voltage. The current and voltage graphs can also be multiplied together to obtain a graph of VA.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.5.4 Current Probes and Accessories

Each SmartReader Plus 3 has four pairs of input connections for use with the Current Probes from Amprobe Instruments. These clamps can be used with a number of accessories to fit most typical applications.

Low Currents
To log very low currents (such as monitoring the operation of electrical appliances), the probe can be used with a Line Splitter. The Amprobe A47L Energizer multiplies the signal to the logger by ten times over a range of 0.1 to 15A. It also allows effective splitting of a two-line conductor, allowing measurements without the need to enter electrical panels or junction boxes.

For European applications, Amprobe's model A47CL is available with screw-in European round prongs, two extra British-type prongs and a British fuse plug adapter. Contact your local ACR representative for pricing and delivery of this product.

High Currents
You can monitor current ranges higher than those available on a standard probe by using it with an additional transformer. For this purpose Amprobe Instruments has available their Amptran® CT50-2 a 50-to-1 transformer (to monitor currents up to 3000 amps). Contact your ACR representative for availability of this probe.

Extending Probe Lead Lengths
The lead length of the Amprobe probes can be extended by splicing in up to 225m (750 ft.) of 2-conductor 18-gauge copper wire.

1.5.5 Specifications

Current Channel Ranges:	With A60FL / A65FL current probes: 5, 25, 100, 250 Amps
	With A70FL / A75FL current probes: 10,50, 250, 500 Amps
	To monitor current ranges up to 3000 Amps, the CT50-2 probe (a 50 to 1 current transformer) can be used in conjunction with the A60FL or the A70FL.
Voltage Channels:	0-5 V DC
Input Impedance:	Typically > 1 M Ohms

Accuracy

Current Channels:	±3.0% of full scale above 10% of range
Voltage Channels:	±0.5% of full scale

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.5.6 Troubleshooting

The SmartReader Plus 3 seems to give wrong readings. What is wrong?

- If the graphs seem incorrect, check the equation number assigned to the graph file. This equation number **must** correspond to the model number and setting of the current probe used. Refer to Setup in this chapter for a table of equations to use with the various current probes and settings.

- If your Realtime readings seem incorrect, check the equation number assigned to the logger channel you are viewing. Make sure it corresponds to the model number and active setting of the current probe you are using.

- If your equation numbers are correctly assigned and you are still getting incorrect readings, it may be because you are measuring currents below 10% of the range. To correct this, make sure the range setting on the probe is at the lowest possible range that will encompass the readings you are interested in. For example, do not use the 250 amp range for recording currents below 25 amps. However, if the readings fluctuate widely (for example, the difference between the day and night time power consumption), it may be necessary to attach two probes -- one on a high range and the other on a low range.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.6 SmartReader Plus 4 Pressure, Temperature and RH Logger

The SmartReader Plus 4 is a general purpose logger that can monitor pressure, temperature and in some models, relative humidity.

Figure 4-1: SmartReader Plus 4

1.6.1 Description

There are two models of the SmartReader Plus 4 data logger:

- **The Standard Model**. This model is a four-channel logger with internal pressure and temperature sensors and an optional EH-020A module for recording relative humidity and temperature remotely. This model is available for different ranges (refer to Specifications).

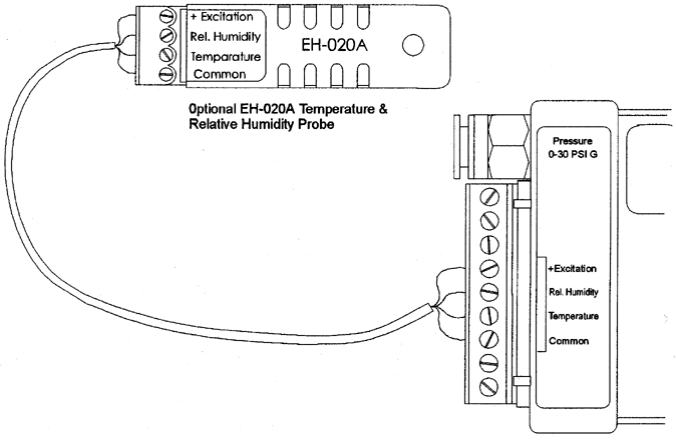


Figure 4-2: SmartReader Plus 4 with EH-020A

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

- **The Low Pressure Model**. This model has an internal pressure channel with 0 to 10" water column sensor and an internal temperature sensor.

1.6.2 Setup

Using the Standard Pressure Channel

1. If you are going to measure pressure, you will need the appropriate fittings to tie into the system or equipment you intend to monitor.

2. Use TrendReader software to enable the pressure channel. Then assign the correct pressure equation for the model you are using.

Channel	Description	Equation
0	Internal Temperature	45
2	External Temperature	Appendix C
3	External Relative Humidity	71
4	Standard Model	see below

Pressure Models

The following table describes the models available and includes the range over which they can be used, the resolution of readings they will provide and the equation you should assign to the pressure channel.

Range	Resolution	Gauge	Absolute	Equation
10" H20 (2.5kPa)	0.006" H20 (0.0015 kPa)	SRP-004-010	n/a	37
±10" H20 Differential	0.006"H20 (0.0015 kPa)	SRP-004-LPD	n/a	37
0 to 5 PSI (30kPa)	0.003 PSI (0.02kPa)	SRP-004-5G	n/a	20
0 to 30 PSI (200kPa)	0.015 PSI (0.1kPa)	SRP-004-30G	SRP-004-30A	8
0 to 100 PSI (700kPa)	0.05 PSI (0.35kPa)	SRP-004-100G	SRP-004-100A	22
0 to 150 PSI (1000kPa)	0.05 PSI (0.5 kPa)	SRP-004-150G	n/a	104

Pressure Measurement Precautions

The SmartReader Plus 4 is designed for long-term, trouble-free performance but there are a few precautions to keep in mind to maximize the benefit it can give you.

- The pressure sensor in the SmartReader Plus 4 is compatible with non-corrosive gases and dry air. It is **not** to be used for liquid pressure measurements.

EH-020A Temperature and Relative Humidity Probe

The EH-020A is a four-wire probe with a temperature and relative humidity sensor. For field-mounting convenience, it also has a magnetic backing and a security eyelet. To use the EH-020A with your SmartReader Plus 4, you must enable the logger's external temperature

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

and humidity channels. To connect the EH-020A probe to your SmartReader Plus 4, follow instruction notes packed with each RH probe set -- see Figure 4-2.

Remote Thermistor Temperature Probe
You can monitor temperature remotely using an ET series temperature probe with your SmartReader Plus 4 by connecting the probe's two wires to the **Temperature** and **Common** terminals. Make sure the External Temperature channel is activated and the proper equation is selected.

1.6.3 Pressure Calibration

The pressure sensor, although subject to accuracy degradation when exposed to contaminants and/or extreme environmental conditions, will drift typically less than 1%/year (under clean conditions). You should check your SmartReader Plus 4 periodically and, if necessary, recalibrate the pressure sensor. In the event that you wish to confirm the pressure calibration of your SmartReader Plus 4 logger, you can perform your own calibration using the adjustment provisions explained in TrendReader software.

The recommended method of calibration is to use a pneumatic pressure calibrator with a preferred accuracy of at least 0.1% full scale.

Procedure
The procedure to calibrate is as follows:

1. Activate the pressure and temperature monitoring channels on your SmartReader Plus 4 if not already enabled.

2. Set the LOW, MID and HIGH calibration values to zero.

3. With the input port on the pressure sensor left unconnected (open to ambient), record the pressure reading you see (it should be close to zero if you are using a gauge sensor or close to atmospheric pressure if you are using an absolute sensor).

4. Subtract the pressure reading you recorded in step 3, from zero for the gauge sensor or from calibrator reading for the absolute sensor, and enter it for the Low calibration adjustment.

5. Connect the logger's pressure sensor to the calibrator, ensuring all connections are completely airtight.

6. Adjust the calibrator to produce a test pressure equal to the full scale range of the logger and record the pressure reading.

7. Subtract the pressure reading you recorded in step 6, from the full scale range of the sensor (the calibrator reading should be the same), and enter it for the Mid calibration adjustment.

8. Save the calibration changes to the logger.

   NOTE: The value of the Ext. column is factory adjusted and should not be changed.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.6.4 Specifications

The following specifications apply to the pressure sensors used in the SmartReader Plus 4:

Type:	Silicon piezoresistive strain gauge
Max. Pressure:	4 x FS
Media:	Noncorrosive gases and dry air
Temp. Range:	
Operating:	-40 to 70°C (-40 to 158°F)
Compensated:	0 to 70°C (32 to 158°F)
Accuracy:	0.5% FS @ 25°C (77°F)
Thermal:	over Compensated Range
10" H20	±3% FS
5 PSI	±1.5% FS
30 PSI	±0.5% FS
100 PSI	±0.5% FS
Linearity:	best fit straight line
10" H20	±0.1% FS
5 PSI	±0.25% FS
30 PSI	±0.1% FS
100 PSI	±0.1% FS
Hysteresis & Repeatability:	
10" H20	±0.2% FS
5 PSI	±0.2% FS
30 PSI	±0.05% FS
100 PSI	±0.05% FS
Long-Term Stability: per year	
10" H20	±0.5% FS
5 PSI	±0.1% FS
30 PSI	±0.1% FS
100 PSI	±0.1% FS

Specifications are subject to change without notice.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.7 SmartReader Plus 4 Low Pressure Differential and Temperature Logger

The SmartReader Plus 4 is a logger that can monitor low gauge and differential pressures and temperature.

Figure 4-3: SmartReader Plus 4 Low Pressure Differential

1.7.1 Description

The SmartReader Plus 4 LPD is a two-channel data logger with internal pressure and temperature sensors. The low-pressure sensor is built into the logger and is capable of measuring low gauge and differential pressure.

1.7.2 Setup

The logger is shipped with two pieces of permanent protective tubing covering the external ports. Never remove these tubes; attach extension tubes to this permanent protective tubing.

1. Connect the interface cable to the logger and to the serial port of your computer.

2. Run TrendReader to communicate with the logger. (The logger has been shipped calibrated and with the appropriate equation. See below for pressure ranges and their equation numbers.)

3. In the SmartReader Plus window, check that the values in the logger match those on the calibration card.

4. Select the sample rate you require.

   NOTE: In Realtime mode the logger reads and displays the pressure every eight seconds. If the sample rate is greater than eight seconds, the **average value** for the sample interval is stored (based on eight-second readings). (Refer to the

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

TrendReader guide for more information.)

5. Save the new setup.

1.7.3 SRP4 LPD Pressure Specifications

Type:	Silicon piezoresistive strain gauge
Max. Pressure:	Four times full scale
Media:	Non-corrosive gases and dry air
Temp. Range:	
Operating:	-40 to 70°C (-40 to 158°F)
Compensated:	0 to 70°C (32 to 158°F)
Thermals Accuracy:	±0.5% FS (over compensated range)
Nonlinearity:	±0.05% FS (best fit straight line)
Hysteresis and Repeatability:	±0.05% FS (typical)
Long Term Stability:	±0.5% FS

Pressure Ranges and their Equations

Range in W.C.	Equation	Accuracy
-0.5 to +0.5"	13	± 0.05"
-1 to +1"	13	± 0.05"
-2 to +2"	88	± 0.05"
-5 to +5"	89	± 0.1"
-10 to +10"	37	± 0.1"

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.8 SmartReader Plus 5 Thermocouple Logger

The SmartReader Plus 5 Thermocouple Logger can monitor and record temperatures from J, K, T, S or E type thermocouples.

Figure 5-1: SmartReader Plus 5

1.8.1 Description

The SmartReader Plus 5 has two external thermocouple temperature channels and one internal thermistor channel.

For information on temperature ranges and resolutions applicable for the different types of thermocouples you want to use, refer to the Specifications section.

1.8.2 Setup

The internal thermistor temperature channel for the SmartReader Plus 5 is used to simulate a reference junction for the thermocouples - it must always be enabled.

Channel	Description	Equation
0	Internal Temperature	45
3	Thermocouple 1	see SmartReader Plus 5 Specifications
5	Thermocouple 2	see SmartReader Plus 5 Specifications

1.8.3 Use

1. Connect a J, K, T, S or E type thermocouple to one or more channels. Make sure that you observe polarity when making connections. To do this, connect a thermocouple's negative wire (usually red) to the "**-**" terminal of the channel you want to use. Connect the

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

other (positive) wire to the "**+**" terminal. The following table lists the ANSI color code for the thermocouple wires:

Thermocouple Type	Positive (+) Wire	Negative (-) Wire
J	White	Red
K	Yellow	Red
T	Blue	Red
S	Black	Red
E	Violet	Red

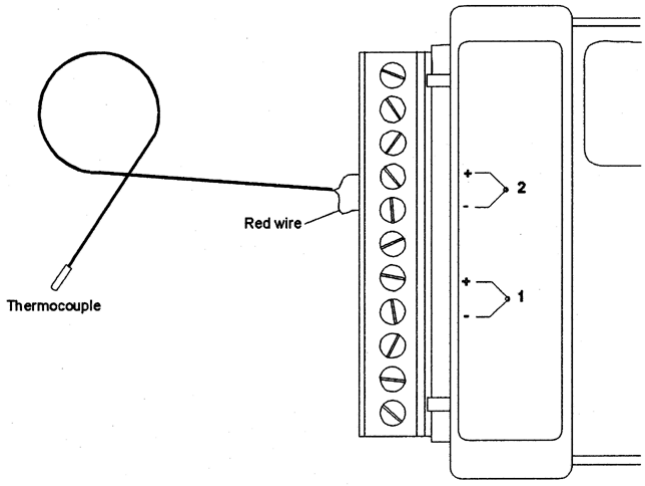


Figure 5-2: SmartReader Plus 5 Thermocouple Connection

2. Connect the logger to your computer and run TrendReader. Select the equation number for each active thermocouple channel (refer to the Specifications section).

3. Check that you have the thermocouple's polarity correct by warming its tip. You will see the Realtime temperature increase if the wires are connected correctly. If the temperature decreases, reverse the connections.

   NOTE: The inputs are not isolated from each other (they use the same common "**-**" terminal internally). This means that the thermocouple tips cannot be touching each other. If they are touching or are fastened to a conducting surface like a metal frame, some looping can occur and the readings may fluctuate. They must be insulated or prevented from making contact with each other electrically. Do not use grounded thermocouples.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.8.4 Specifications

Accuracy: ±0.5% of range plus resolution

Thermocouple	Range	Resolution	Equation
J	-50 to 600°C (-55 to 1100°F)	0.30°C (0.55°F)	50
K	-100 to 1150°C (-145 to 2100°F)	0.50°C (0.90°F)	52
T	-200 to 400°C (-325 to 750°F)	0.40°C (0.75°F)	54
S	0 to 1450°C (32 to 2642°F)	1.0°C (1.8°F)	74
E	-50 to 680°C (-58 to 1250°F)	0.24°C (0.44°F)	90

Specifications are subject to change without notice.

1.8.5 Manual Calibration

A simple way to manually adjust the calibration values on a SmartReader Plus 5 thermocouple logger follows. For each active channel:

1. Install the thermocouple and set the proper equation number for that thermocouple type. Set the TrendReader software into Realtime mode.

2. Using a valid low reference temperature (as low as possible), observe the Realtime reading and adjust the Low calibration value until the logger displays the reference temperature.

3. Using a valid high reference temperature (as high as possible), observe the Realtime reading and adjust the Mid calibration value until the logger displays the reference temperature.

To obtain the best results from the calibration, set the reference temperatures as far apart as possible.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.9 SmartReader Plus 6 Thermocouple Logger

The SmartReader Plus 6 Thermocouple Logger can monitor and record temperatures from J, K, T, S or E type thermocouples.

Figure 6-1: SmartReader Plus 6

1.9.1 Description

The SmartReader Plus 6 has seven external thermocouple temperature channels and one internal thermistor temperature channel for cold-junction compensation.

1.9.2 Setup

The internal thermistor temperature channel for the SmartReader Plus 6 is used to simulate a reference junction for the thermocouples - it must always be enabled.

Channel	Description	Equation
0	Internal Temperature	45
1	Thermocouple 1	see SmartReader Plus 6 Specifications
2	Thermocouple 2	see SmartReader Plus 6 Specifications
3	Thermocouple 3	see SmartReader Plus 6 Specifications
4	Thermocouple 4	see SmartReader Plus 6 Specifications
5	Thermocouple 5	see SmartReader Plus 6 Specifications
6	Thermocouple 6	see SmartReader Plus 6 Specifications
7	Thermocouple 7	see SmartReader Plus 6 Specifications

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.9.3 Use

1. Connect a J, K, T, S or E type thermocouple to one or more channels. Make sure that you observe polarity when making connections. To do this, connect a thermocouple's negative wire (usually red) to the "**-**" terminal of the channel you want to use. Connect the other (positive) wire to the "**+**" terminal. The following table lists the ANSI color code for the thermocouple wires:

Thermocouple Type	Positive (+) Wire	Negative (-) Wire
J	White	Red
K	Yellow	Red
T	Blue	Red
S	Black	Red
E	Violet	Red

2. Connect the logger to your computer and run TrendReader. Select the equation number for each active thermocouple channel (refer to the Specifications section).

3. Check that you have the thermocouple's polarity correct by warming its tip. You will see the Realtime temperature increase if the wires are connected correctly. If the temperature decreases, reverse the connections.

NOTE: The inputs are not isolated from each other (they use the same common "**-**" terminal internally). This means that the thermocouple tips cannot be touching each other. If they are touching or are fastened to a conducting surface like a metal frame, some looping can occur and the readings may fluctuate. They must be insulated or prevented from making contact with each other electrically. Do not use grounded thermocouples.

1.9.4 Specifications

Accuracy: ± 0.5% of range plus resolution

Thermocouple	Range	Resolution	Equation
J	-50 to 600°C (-55 to 1100°F)	0.30°C (0.55°F)	50
K	-100 to 1150°C (-145 to 2100°F)	0.50°C (0.90°F)	52
T	-200 to 400°C (-325 to 750°F)	0.40°C (0.75°F)	54
S	0 to 1450°C (32 to 2642°F)	1.0°C (1.8°F)	74
E	-50 to 680°C (-58 to 1250°F)	0.24°C (0.44°F)	90

Specifications are subject to change without notice.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.9.5 Manual Calibration

A simple way to manually adjust the calibration values on a SmartReader Plus 6 thermocouple logger follows. For each active channel:

1. Install the thermocouple and set the proper equation number for that thermocouple type. Set the TrendReader software into Realtime mode.

2. Using a valid low reference temperature (as low as possible), observe the Realtime reading and adjust the Low calibration value until the logger displays the reference temperature.

3. Using a valid high reference temperature (as high as possible), observe the Realtime reading and adjust the Mid calibration value until the logger displays the reference temperature.

To obtain the best results from the calibration, set the reference temperatures as far apart as possible.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.10 SmartReader Plus 7 Process Signal Logger

A multi-channel, multi-purpose logger, the SmartReader Plus 7 provides a versatile means of logging a wide variety of measurement signals. It features seven input channels configured for easy interface with common transducer and transmitter outputs.

Figure 7-1: SmartReader Plus 7

1.10.1 Description

The SmartReader Plus 7 can measure and record data from five separate channels of analog DC voltage covering the ranges of 0 to 200 millivolts, 0 to 2.5 volts, 0 to 5 volts and 0 to 10 volts and from two DC current channels covering the range of 0 to 25 milliamps.

How the SmartReader Plus 7 Works
Voltage channels use a pre-amplifier to provide a high input impedance and adjust the signal for maximum resolution by the A/D converter. All digital values are converted to their proper engineering units by equations in TrendReader software.

Current flow through a loop is logged by measuring the voltage drop across an internal 20 ohm input resistor. This voltage drop is amplified to use the full range of the A/D converter. The digital values are then processed into engineering units by an equation in TrendReader software.

1.10.2 Setup

This section provides guidelines to follow to get you started with your SmartReader Plus 7.

1. The first step in using your SmartReader Plus 7 is to decide what information, or parameters, you want to log. For example, you may simply wish to replace an existing hard-wired 4-20mA chart recorder or, instead, monitor from a special multiple-transducer circuit that you have assembled.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

2. Determine what sensors, transducers or transmitters you need to do the job (if not already present). Compatible transducers for monitoring temperature, relative humidity, pressure, speed, and many more variables are available through a wide variety of vendors (see Selecting Transducers and Transmitters).

3. Modify the channels externally (using resistors), if required, for maximum resolution (see Customizing Input Ranges).

4. Write a Custom Equation to convert the internal A/D converter readings from the transducer or circuit you want to monitor into the proper engineering units required (for example, a 4-20mA signal representing 0 to 10,000 l/min). For help writing these equations refer to the TrendReader guide.

5. Decide how you are going to power your transducers (if required). You can, for example, use a standard power supply and create a circuit like that shown in Figure 7-2.

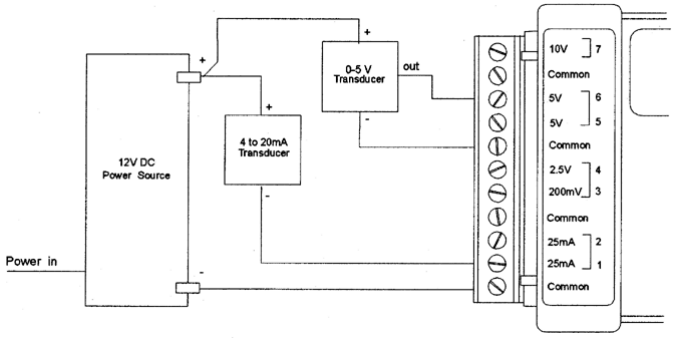


Figure 7-2: Transducer Power Supply Connection

6. Connect your transducers or transmitters and check operation by observing the Realtime value displayed by TrendReader software. If you can, try to exercise your transducers (make them change their output) to ensure that everything works. If it does, then you are ready to place your assembly in the field to start logging.

Channel	Description	Equation
0	Internal Temperature	45
1	25 mA	6
2	25 mA	6
3	200 mV	19
4	2.5 V	7
5	5 V	18
6	5 V	18
7	10 V	17

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Avoiding Ground Loops
Take special care to avoid ground loop problems when you use your SmartReader Plus 7. A ground loop can occur when there is more than one path to ground in your logger-transducer circuit. Ground loops can damage your SmartReader Plus 7 as well as your transducers. To avoid ground loop problems in your SmartReader Plus 7 circuit:

1. Do not use more than one grounded power supply to excite your transducers.

2. Do not connect your logger to your computer for Realtime readings unless:

   - your computer is battery-operated (i.e. not grounded) or
   - your transducer power supply is not grounded.

If you must use more than one grounded power supply in your SmartReader Plus 7 circuit, *each* transducer you use must be isolated. If you must use non-isolated transducers, then you must use a Signal Repeater/Loop Isolator between the transducer output and the SmartReader Plus 7 input.

Wiring Notes and Considerations
1. The SmartReader Plus 7 has four common inputs (labeled "**Common**"). These are not isolated from each other and can be used as the negative "**-**" connection for the power supply (or battery) and any of the transducers being logged by the SmartReader Plus 7.

2. The 200mV channels "float" when no connection is made to them. They can be expected to read a positive voltage when left unconnected. When connected, however, they will read the correct input voltage.

3. The 25mA channels read positive current only. *Make sure to observe polarity.* If you are using both channels simultaneously, ensure that both 4-20mA transmitters operate with their negative (-) terminals tied together.

1.10.3 Choosing Input Channels

The SmartReader Plus 7 has seven external input channels to use in your particular applications.

The resolution of your SmartReader Plus 7 logger is twelve bits. This means that it can resolve analog signals into 4096 discrete steps. All channels have a resolution of 0.025% full scale (1/4096 x 100%) which produces a very detailed graph in most applications.

The SmartReader Plus 7 can be used for measuring signals with a full scale output as low as 20mV on the 200mV channel (this translates to 1 part in 410 which is better than eight bit resolution); this is useful for Wheatstone bridge type transducers which typically have a full scale output in the tens of millivolts.

> **WARNING**: The 200mV channel is more sensitive to noise signals generated by the environment the logger is placed into - shielded cables should be used.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.10.4 Customizing Input Ranges

The standard input ranges on the SmartReader Plus 7 should be suitable for most process signal applications but occasionally you may require measurement of non-standard input levels where resolution is a primary concern. Ranges can be adapted easily by using either one or two external resistors. TrendReader software has **Equation** functions that can be used to scale the data to the new input levels.

The table below lists several possible input signal ranges and the recommended channels to use. It also lists alternative channels that can be used for additional simultaneous monitoring capability. These alternative channels will, however, require external resistors.

Range	Standard	Alternative
0 to 500 mV	2.5 V	200mV
0 to 1V	2.5 V	200mV
0 to 2V	2.5 V	200mV
0 to 3V	5 V	2.5V, 200mV
0 to 6V	10 V	5V, 2.5V, 200mV
0 to 20V	10 V	5V, 2.5V, 200mV
0 to 2mA	25 mA	200mV
4 to 20mA	25 mA	2.5V, 200mV
0 to 50mA	n / a	25mA, 5V
0 to 100mA	n / a	25mA, 10V

In the above table, the *Range* column lists examples of input signals that you may wish to monitor using your SmartReader Plus 7. The *Standard* column lists the channel you would normally choose to monitor that particular signal. The *Alternative* column lists other channels that can be used to monitor the same input signals. In most cases, these channels will need to be fitted with external resistors.

The resistor value that you will require to modify each SmartReader Plus 7 input channels is selected by inserting your special input requirements into a simple equation. The following sections detail these equations and the method of tying in these resistors.

10 Volt Channel

The 10 volt channel can be modified to span higher ranges (greater than 10 volts DC) by adding a single resistor to the "**10V**" terminal shown in Figure 7-3. The value of the resistor (R) can be calculated by following the formula below, based on the desired voltage input range (Ein):

$$R = 102{,}000 \times Ein - 1{,}020{,}000$$

For example, if you wish to measure up to 20 volts, the resistor value should be:

$$102{,}000 \times 20 - 1{,}020{,}000 = 1{,}020{,}000 \text{ ohms}$$

NOTE: It is recommended to use resistors with a resistance tolerance of 1% or better.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Since you will not always be able to get the exact resistor value that you calculated, you can determine the logger's actual input range by plugging the value of the resistor (R) you obtain back into the equation. For example, if the closest resistor you could obtain was 1.05M ohms, then the actual voltage input range would be:

$$Ein = (R + 1{,}020{,}000) / 102{,}000$$

$$(1{,}050{,}000+1{,}020{,}000) / 102{,}000 = 20.29V$$

This value will be needed when it comes time to create your own custom equation using TrendReader software.

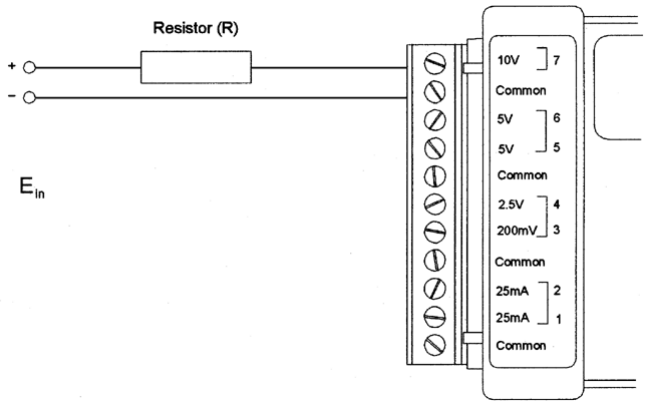


Figure 7-3: Extended Voltage Range on 10V Channel

You can also easily convert the 10V channel to measure 0 to 100mA current simply by putting a 100 ohm resistor (minimum rating: 2 watts) between the "**10V**" and "**Common**" terminals.

5 Volt & 2.5V Channels

The 5 volt and 2.5 volt channels can be modified to span higher ranges (greater than 5 and 2.5 volts DC respectively) by adding a single resistor, in the same way as shown for a 10V channel in Figure 7-3 to the "**5V**" and "**2.5V**" terminals. The value of the resistor (R) can be calculated by the following equations, based on the desired voltage input range (Ein). A final Range can be determined to write a custom equation in TrendReader software.

Terminal	Resistor (R)	Range
5 V	R = 202,000 x Ein - 1,010,000	Ein = (R + 1,010,000) / 202,000
2.5 V	R = 408,000 x Ein - 1,020,000	Ein = (R + 1,020,000) / 408,000

200mV Channel

The 200mV channel can be modified to span higher ranges (greater than 200mV DC) by adding *two* resistors to the input terminals as shown in Figure 7-4. The value of the resistor

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

marked "**10k**" must be 10,000 ohms ±1% or better.

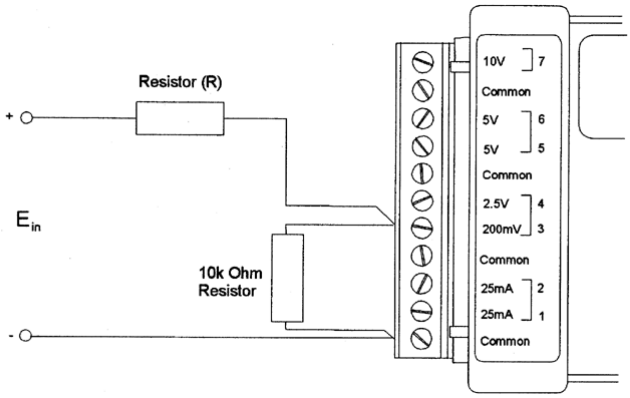


Figure 7-4: Modified 200mV Channel

The value of the resistor (R) and final Range can be calculated with the following equations:

$$R = 40{,}000 \times Ein - 10{,}000$$

$$Ein = (R + 10{,}000) / 40{,}000$$

25mA Channel

The 25 milliamp channel can be modified to span higher ranges (greater than 25mA DC) by adding a single resistor across the input terminals as shown in Figure 7-5. The value of the resistor (R) can be calculated by the following the formula below, based on the desired current input range (Iin) in mA**:

$$R = 500 / (Iin - 25)$$

** Where: 500 = max input voltage in mV
25 = max current input in mA

Make sure the resistor can withstand at least twice the power you will be sending it. To calculate this, use the following equation:

$$P = 2 \times I_n^2 \times R$$

Where:

P = Minimum Power Rating of resistor (in watts)
Iini= Maximum amperage expected through resistor (in Amps)
R = Resistor value (in ohms)

For example, a 20 ohm resistor calculated to measure currents up to 50mA will require a

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

power rating greater or equal to 0.1 watts. Therefore, a quarter watt resistor will do fine.

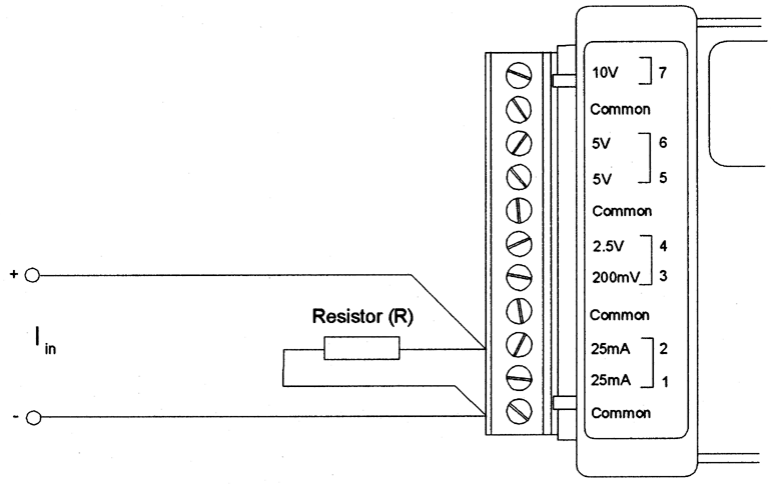


Figure 7-5: Modified 25mA Channel

You can also modify the 200mV channel to log current loop signals with greater sensitivity than the two 25 mA channels. Put a 100 ohm resistor across the "**200mV**" and "**Common**" terminals and you will be able to log currents from 0 to 2.0mA with approximately ten times the resolution of the 25mA channels. The equation to use to determine the other current (Iin) ranges, in milliamps, is:

$$R = 200 / I_{in}$$

Resistors

Resistors that can be used with the SmartReader Plus 7 are readily available at most electronic parts supply stores. Ask for precision 1% metal film resistors with a temperature coefficient of less than 500ppm. The most common ones are quite small and made in the form of a cylinder with axial leads. To show the value of the resistor, either there is:

- a color code painted on each resistor in the form of bands
- a number (followed by a letter) stamped on them

For resistors with a tolerance of 2% or looser, there are four bands or three number digits while the resistors that are 1% or better have five rings or four number digits. In the case of 1% values the first three digits or rings correspond to the resistors value and the fourth digit or band is the number of zeros to be added. The fifth band or letter indicates the manufacturer's tolerance of the resistor. For example, a 30,900 ohms resistor would be shown as orange, black, white, red, black or "3092F".

Color	Number	Tolerance	Letter
Black	0	1%	F
Brown	1	2%	G
Red	2		

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Orange	3		
Yellow	4		
Green	5		
Blue	6		
Violet	7		
Grey	8		
White	9		
Gold		5%	J
Silver		10%	K
None		20%	

WARNING: Using resistors with tolerances looser than 1%, poor temperature coefficients and long-term drift characteristics will create undesirable measurement errors.

1.10.5 Selecting Transducers and Transmitters

A *transducer* is defined as a device that receives energy from one system and retransmits it, in a different form, to another system. A *transmitter* is a term usually reserved for transducers in a current loop circuit. In this section, the terms transducer and transmitter will be used interchangeably.

For a transducer to be useful, the retransmitted signal must be compatible with standard instrumentation. For the SmartReader Plus 7 logger, this can be either in the form of an analog DC voltage or current.

Many compatible transducers exist for measuring such variables as temperature, relative humidity, pressure, speed, pH and more. You can obtain these from a wide variety of manufacturers or distributors. An extensive listing of sensors and companies is published yearly by *Sensors* Magazine.

To figure out what to look for when choosing transducers, it is helpful to know a few technical terms and how they relate to use with your SmartReader Plus 7 logger.

Excitation Voltage
This term refers to the input voltage that a transducer requires in order for it to work properly. It is either specified as a range (for example, 9 to 30 volts DC) or a specific voltage (for example, 10 volts DC). When a range is specified, it means you can use an unregulated power supply (such as a battery) as long as voltages within the range are provided. Usually, if a specific voltage is required, it means you require a regulated power supply.

When an unregulated power supply is specified for the excitation voltage, a regulated one may also be used. The reverse, however, is not true. Millivolt pressure transducers, for example, usually require regulated power supplies.

Maximum Impedance
An important consideration when choosing transducers is the requirement for input or loop

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

impedance. This simply refers to how much resistance your instrumentation (for example, the SmartReader Plus 7) can have before it will begin to cause problems. For voltage inputs, a very high impedance is usually required (greater than 10k ohms). This prevents the unnecessary draining of current from the transducer circuit. The SmartReader Plus 7's voltage inputs are all high impedance (greater than 1M ohms).

For current loop inputs, it is advantageous to have a very low impedance (the SmartReader Plus 7's current channels have a low 20 ohm impedance). This helps to minimize the voltage requirements and power consumption of the circuit. Check the specifications for the transducers you intend to use to ensure the SmartReader Plus 7's input impedance is acceptable.

Two-Wire Transmitters
Two-wire transmitters are transducers that form part of a current loop circuit. They vary the current flow in accordance with changes in the variable which they are sensing. Most two-wire transmitters have a 4-20mA output.

Three-Wire Transducers
Three-wire transducers have three connections: a supply (excitation) voltage input (V+IN), an output voltage (V+OUT) and a common (COM-). You can usually tell if a transducer is 3-wire by reviewing the wiring diagram and looking for a *single* common connection.

Four-Wire Transducers
Four-wire transducers fall into two categories: line-type and Wheatstone bridge types. No more than one line-type transducer can be attached to a SmartReader Plus 7 unless it has an isolated output (no electrical connection to the line). More than one bridge-type transducer can only be hooked to a SmartReader Plus 7 if each has an isolated power supply.

Output
The specified output of a transducer or transmitter will determine whether it is compatible for use with your SmartReader Plus 7. Some of the most popular transducer outputs (such as 0 to 2.5V or 0 to 5V DC) are directly compatible with the logger. The most popular transmitter output is 4 to 20mA which can easily be used with the SmartReader Plus 7.

1.10.6 Specifications

Voltage and Current Inputs

Ranges:	0 to 2.5 volts DC 0 to 5 volts DC 0 to 10 volts DC 0 to 200mV DC 0 to 25mA
Resolution:	0.025% (12-bit)
Accuracy:	±0.5% full scale
Input Impedance:	>1 megohm (all voltage channels) 20 ohms (0 to 25mA channels)

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Overload Protection:	Voltage channels: ±40V Current channels: ±70mA (both are reverse-polarity protected)
Transducer Restrictions:	The use of one power supply common only is recommended to avoid ground loops or use loop isolators.

Specifications are subject to change without notice.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.11 SmartReader Plus 8 Eight-Channel Temperature Logger

The SmartReader Plus 8 is a versatile logger for recording temperatures in a wide range of environmental and industrial applications. It can record up to eight temperature channels simultaneously.

Figure 8-1: SmartReader Plus 8

1.11.1 Description

The SmartReader Plus 8 has seven external temperature channels (for remote temperature probes) and one internal thermistor sensor.

1.11.2 Setup and Use

The following procedure will help you prepare your SmartReader Plus 8 for your temperature monitoring applications.

1. Setup and activate the channels you intend to monitor using TrendReader software. Disable any channels you are not going to use to conserve memory.

2. If you are using external channels, make sure to use thermistor sensors appropriate for the measurements you want to take (for assistance, please refer to Appendix C Thermistor Temperature Probes). Also, confirm that the equation number you are using for each of your probes is correct.

3. To connect remote temperature probes (two-wire), simply connect one lead into an active channel (labeled **1** to **7**) and the other into a terminal marked "**Common**". It does not matter which lead goes to which terminal. You can connect more than one thermistor probe lead to the same **Common** terminal. For example, Figure 8-2 shows two external probes connected to channels 2 and 3 sharing the same **Common** terminal. If you are using a thermistor probe with shielded cable, terminate the shield wire by connecting it to

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

any **Common** terminal.

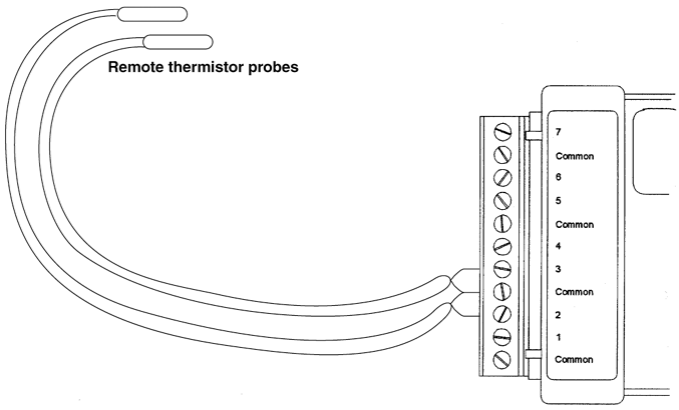


Figure 8-2: Connecting External Temperature Probes

Accessories
The ET Series Temperature sensors are thermistor probes that can be used easily with your SmartReader Plus 8 for remote temperature measurements. The advantage of these probes is that they can be used for a wide range of temperatures, are very versatile (they can be used to record liquid or surface temperatures) and their small size permits them to be placed in hard-to-get-at locations such as in ductwork or under pipe insulation.

For more information on choosing and using thermistor probes, refer to Appendix C Thermistor Temperature Probes.

You can purchase additional screw-type terminal block connectors for your SmartReader Plus 8. These make it easy to permanently install sensors around buildings and systems. Simply wire them to the unconnected blocks and when you are ready to collect data, you can simply plug in your SmartReader 8 logger. For analysis, you can just unplug it again without having to disconnect any sensors.

Other Applications
For information on how you can monitor resistance or switch status with your SmartReader Plus 8, refer to Appendix A Measuring Resistance and Switch Status.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.12 SmartReader Plus 9 Pulse Logger

The SmartReader Plus 9 is a two-channel multi-purpose counter and logger. With it you can monitor a wide variety of measurement parameters.

Figure 9-1: SmartReader Plus 9

1.12.1 Description

Featuring two input channels configured for easy interface with common switch and transducer outputs, the SmartReader Plus 9 has the capability to count and record voltage pulses and switch contact closure frequency. The SmartReader Plus 9 does not have an internal temperature channel.

1.12.2 How the SmartReader Plus 9 Counts

The SmartReader Plus 9 has two channels. The channels can count the opening and closing of external switch contacts and/or the occurrence of DC voltage pulses. Each channel has a selectable slow or fast input. The SmartReader Plus 9 can only count pulses from one input at a time on each channel.

The pulse logger can count up to 4095 switch contact closures or pulses over any sampling interval. For example, if you select a sixteen second sampling interval, the SmartReader Plus 9 can record a maximum of 255 closures per second (4095/16). If the number of closures or pulses exceeds 4095 during a sampling interval, the logger will record a count of 4095 for that interval.

The logger keeps track of the number of times a switch opens and closes by continuously maintaining a voltage potential across the input terminals. Every time the voltage changes from high to low (i.e. switch closing) and back to high again (i.e. switch opening), the logger increments its internal counter.

Counting voltage pulses (also called logic inputs) is similar to counting switch contacts, only

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

instead of the logger supplying the voltage potential, the logger detects the voltage level of the pulse. The pulse must have a low level voltage less than 0.5 volts DC and the high level voltage must be from 4.5 to 24 volts DC.

The minimum pulse length and minimum interval between pulses must be 2 milliseconds for the slow input and 10 microseconds for the fast input. For the SmartReader Plus 9 to register a count, the input voltage must go from a low level to a high level and back again to a low level.

1.12.3 Setup and Use

The following steps will guide you through the procedure of setting up and using your SmartReader Plus 9 Pulse Logger.

1. Always make sure that the circuit you want to monitor is compatible to use with the logger before connecting it. Refer to the Specifications section for details on the type of switches and logic signals that will work. Key things to note are:

   - If you are going to be monitoring the opening and closing of switches, there must not be a power source connected to the contacts (the contacts must be "dry").
   - If you wish to monitor a circuit that produces pulsed signals, then the low level must fall between 0 and 0.5 volts DC and the high level must be between 4.5 volts and 24 volts DC.
   - The frequency of the pulses or contact closures that you want to monitor must not exceed the maximum capability of the SmartReader Plus 9 which is 4095 over any sampling period.

2. Set the mode of operation of your SmartReader Plus 9 in TrendReader.

Channel	Description	Equation
0	Pulse Input 1	81
1	Pulse Input 2	81

3. Connect your switches or signals to check the operation of the logger by viewing the Realtime reading while generating pulses. If the value increments, then you are ready to start logging in the field.

1.12.4 Specifications

Pulse Inputs

Range:	4095 pulses/sample period
Accuracy:	±1 pulse/sample period
Absolute Max. Voltage:	+24/-22 volts DC
Input Impedance:	>1.0M for Vin<5V;

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

>4.0K for Vin>5V

Min. Pulse Width
50% Duty Cycle: Slow input:2 milliseconds
Fast input:10 microseconds

Restrictions: Maximum frequency over sample interval must not exceed channel range (the total count will stop at 4095)

Connections: Removable screw-type terminal strip

Switch Inputs
Input-type: Uncommitted "dry" contacts (relay or switch)

Excitation: 5 microamps contact current
3.6 volts open circuit

Contacts: Sealed gold-plated recommended

Voltage Input
Input-type: Active logic signals

Input Voltage: 0 to 0.5 volts DC low
4.5 to 24 volts DC high

Specifications are subject to change without notice.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.13 SmartReader Plus 10 RTD Temperature Logger

The SmartReader Plus 10 is a temperature logger with four channels: an internal thermistor channel and three external channels specifically designed for use with RTD (Resistance Temperature Detector) temperature probes.

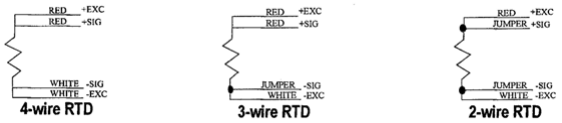
Figure 10-1: SmartReader Plus 10

1.13.1 Description

Two, three, and four-wire RTDs may be used with the SmartReader Plus 10, however, four-wire RTDs produce the highest accuracy. RTDs with a Temperature Coefficient Resistance (TCR) of 0.00385 can be used with this data logger.

1.13.2 Setup

1. Connect the RTDs to the terminal strip. The connection varies depending on the type of RTD used:



NOTE: For the best results, connect the jumper wire as closely as possible to the probe.

2. Run TrendReader software.

3. In the setup window, assign equation numbers as follows:

For results in temperature:

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

For the internal channel, use equation 45
For the 100 ohm probes, use equation 86
For the 1000 ohm probes, use equation 87

For results in resistance (ohms):
For the internal channel, use equation 45
For the 100 ohm probes, use equation 84
For the 1000 ohm probes, use equation 85

NOTE: Even equation numbers are for 100 Ω probes and odd equation numbers are for 1000 Ω probes.

4. Adjust the remaining setup options as desired then save the setup.

1.13.3 Specification of RTD Channels

The following specifications are for:
4-Wire Platinum 100 Ohm @ 0° C & TCR = 0.00385
4-Wire Platinum 1000 Ohm @ 0° C & TCR = 0.00385

Description:	**Value:**
+SIG Input Impedance:	>1 Meg. ohms
-SIG Input Impedance:	>1 Meg. ohms
Excitation Current	<=1mA
Temp. Range (100 & 1000 Ω probes):	-230 to 300°C (-382 to 572°F)
*Accuracy ** (100 & 1000 Ω):*	± 0.3°C (0.54°F) + resolution or ± 0.06 % full scale + resolution
Resolution (100 Ω & 1000 Ω):	± 0.14°C (±0.25°F)
Resistance Range (100 Ω):	5 to 210 Ω
*Accuracy ** (100 Ω):*	± 0.13 Ω + resolution or ± 0.06 % full scale + resolution
Resistance Range (1000 Ω):	50 to 2100 Ω
*Accuracy ** (1000 Ω):*	± 1.3 Ω + resolution or ± 0.06 % full scale + resolution
Resolution (100 Ω):	± 0.05 Ω
Resolution (1000 Ω):	± 0.5 Ω

** For internal channel specifications, please see Common Specifications for SmartReader Plus loggers*

*** Temperature compensated for the range of -20 to 80°C (-4 to 176°F)*

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

1.14 Conservation Logger Temperature, RH and 5V Input Logger

The Conservation Logger is a self-contained temperature and relative humidity logger with two external channels for use with a variety of sensors.

Figure 11-1: Conservation Logger

1.14.1 Description

The Conservation Logger is designed to monitor temperature and humidity (internal or external) and determine if the readings measured are out of tolerance based on preset thresholds. It is equipped with an LED light that will flash its alarm if measurements raise above or below set limits.

Alarm Flash Mode
When the Alarm Flash mode is selected the logger will check the current sample and determine if it is above or below the high or low alarm threshold values. If the sample is out of tolerance then the logger will start a delay timer to allow the environment to return to normal limits. If the environment does not return to normal limits the alarm will be triggered and the Alarm LED will begin to flash.

Once an alarm is triggered it is locked and will not clear until the logger is cleared or set up.

Flash Delay
The Flash Delay is the maximum allowable period of time (based on sample periods) for a channel to be out of tolerance before alarming. The Flash Delay is started when a channels current sample is found to be out of the preset alarm limits. Once the delay timer is started it will count down from the preset number of samples to zero. When zero is reached the alarm will be locked and the Alarm LED will begin to flash.

The Flash Delay timer will be reset if the channel that reported the alarm returns to normal operating conditions (within the preset tolerances) before the timer reaches zero.

If a threshold is crossed again the delay timer will restart.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.14.2 Setup

Make sure to enable each channel you want to use. If you are not using a channel, disable it in order to save memory.

Channel	Description	Equation
0	Internal Temperature	45
1	Internal Relative Humidity	71
2	External 5VDC	18
3	External 5VDC	18

NOTE: When you activate the RH channel, you must also enable its corresponding temperature channel, as well, in order to temperature compensate the RH sensors.

Precautions

The Conservation Logger's RH Sensor is designed for long-term trouble-free performance, but there are a few precautions to keep in mind to maximize the benefit it can give you.

- Never expose the sensor to organic solvents or ionic-laden liquids. Any chemical compound that attracts polymers may affect the sensor.
- The RH sensor is particularly susceptible to contamination by sulfur gases and sulfur compounds. **DO NOT SMOKE NEAR THE LOGGER!**
- Always return your Conservation Logger to a re-sealable plastic bag during non-use to maximize the in-calibration life of the RH sensor.

1.14.3 Accessories

You can obtain replacement RH Sensors, remote temperature probes, temperature and relative humidity probes for use with your Conservation Logger.

The Conservation Logger can also be combined with the Telaire 7001 Handheld Monitor.

1.14.4 Relative Humidity Calibration

Each relative humidity sensor has been individually calibrated in an environmental chamber with standards traceable to the National Institutes of Standards and Technology (NIST).

The Conservation Logger is supplied with a calibration certificate which provides calibration values. These calibration values must be entered and stored in the logger during initial setup. If your RH sensor is out of calibration, you can simply replace it with a new one.

NOTE: A straight replacement of the RH sensor will introduce an additional +2% tolerance on the RH accuracy. Calibration of the RH channel with the new RH sensor is recommended.

In the event that you wish to confirm the RH calibration of your sensor, you can perform your own field test. Refer to Appendix B Temperature and Relative Humidity Calibrations for more information on RH testing.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Interchangeable replacement RH sensors for loggers are available through your dealer. For best accuracy, it is recommended these be calibrated together with the logger - consult your ACR representative for price and availability of this service.

1.14.5 Troubleshooting

If you are getting what appear to be wrong readings, consider the following before recalibrating the sensors. Sensors sample the atmosphere (or medium) in the immediate vicinity of the sensors themselves. The physical state of the atmosphere and its degree of uniformity and turbulence will limit the validity of a measurement at some distance from the sensor. This becomes especially apparent for the measurement of ambient temperature and relative humidity.

In a room, temperature and RH levels may vary dramatically from location to location. Such factors as air stratification, drafts and proximity to heat or humidity sources (people, equipment, moisture, solar gain, etc.) can contribute to a wide variance in conditions even within a small confined area. The individual sensors associated with your Conservation Logger measure and record temperature and RH only in one location. They do not, in any way, represent an overall reading.

If you decide to check the calibration of your Conservation Logger RH sensor using a Sling Psychrometer, keep in mind the following:

- Any instrument that requires a person to be present at, or in very close proximity to the RH sensor in order to get a reading, will have a measurement error introduced to it. That is because the body readily gives off heat and moisture that is especially noticeable at lower RH levels.

- The time taken between slinging the psychrometer and reading it can exhibit several degrees of inaccuracy in the wet bulb reading. Air currents around the body, whether it is slung in the shade of a building or in sunlight, not knowing how to tie the wet sock, its condition, and the purity of water used, all contribute to error. In addition, interpolating the data from a psychrometric chart can add another 2 to 4% to the accumulative error.

1.14.6 Specifications

Temperature Sensor

Type:	NTC Thermistor
Range:	-40 to 70°C(-40 to 158°F)
Accuracy:	+/- 0.2°C over the range of 0 to 70°C (+/- 0.3°F over the range of 32 to 158°F)
Resolution:	0.03°C at 25°C (0.05°F at 77°F); better than 0.07°C (0.12°F) between -25 and 70°C (-13 and 158°F); better than 0.13°C (0.23°F) between -40 and -25°C (-40 and -13°F)

RH Sensor

Type:	Capacitive thin polymer film

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Range:	0 to 95% RH
Accuracy:	±3% RH from 10 to 90% (-20 to 40°C [-4 to 104°F])
Resolution:	Better than 0.04% RH between 25 and 60% RH at 25°C (77°F)
Environmental Conditions:	The RH sensor is relatively immune to chemical contamination but when exposed to extreme environmental conditions, accuracy degradation could result. For long-term stability and reliable readings, the sensor should not be subjected to liquid immersion or exposed to high concentrations of organic solvents, corrosive agents, sulfur gases and strong acids or bases. Dust settling on the sensor surface will not affect sensor performance except possibly to decrease the speed of response.
Chemical Tolerances:	Limits for different chemical groups **1**. Organic solvents typically 1,000...10,000 ppm **2**. Corrosive agents (strong acids S02, H2SO4, Cl2, HCl, H2S etc.) typically 1...10 ppm **3**. Weak acids typically 100...1,000 ppm **4**. Bases typically 10,000...100,000 ppm

External Sensors(2):

Range:	Any two sensors with a 0-5 VDC output

Specifications are subject to change without notice.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.15 APPENDIX A Monitoring Resistance and Switch Status

Monitoring Resistance and Switch Status

1.15.1 Measuring Resistance

You can also use your SmartReader Plus 1, 2, 4 and 8 model loggers to monitor resistance, instead of just temperatures. This capability allows you to monitor devices other than just thermistors (for example, potentiometers, level indicators or any other device that varies resistance in accordance with a known parameter).

To use the thermistor temperature channel on your SmartReader Plus logger to measure resistance, you must change the channel's equation number to the one for resistance. To do this, select **Equation 44 - Resistance** when setting up the logger in TrendReader software.

The highest resolution of the resistance measurements occurs at a 10k ohms midpoint.

1.15.2 Monitoring Switch Status

You can also use your SmartReader Plus 1, 2, 4 and 8 model loggers to record the status of uncommitted mechanical switch contacts (see Figure A-1). The switch you want to monitor must be a "dry" contact, which means that it must have no connection to any type of voltage, power or ground.

To use the thermistor temperature channel on your SmartReader Plus data logger to monitor switch status, you must change the channel's equation number to the one for switch status. To do this, choose **Equation 41 - Switch Status** when setting up the logger using

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

TrendReader software.

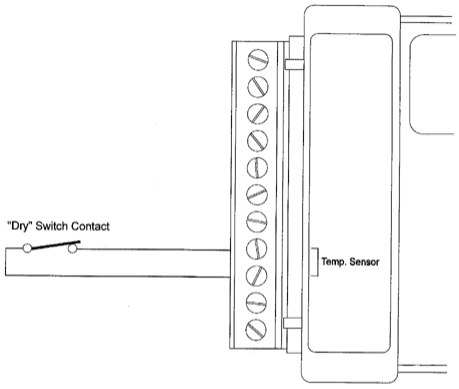


Figure A-1: Monitoring Switch Status

When monitoring the status of a switch with your data logger, keep in mind that the logger will not detect more than one change per sample period. For this reason, use a fast sample rate if you expect the switch to open and close frequently.

The type of graph produced when monitoring switch status is a square wave that rises to a maximum value when the switch is closed, and falls to a minimum value when the switch is open.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.16 APPENDIX B Temperature and Relative Humidity Calibration

Temperature and Relative Humidity Calibration

1.16.1 Temperature and Relative Humidity Calibration

This chapter provides instructions on how you can recalibrate your RH modules, EH-020A External Temperature and Relative Humidity probes and any thermistor temperature probes.

1.16.2 Thermistor Calibration

If you do not have accurate resistance-temperature data on your thermistors (available with all interchangeable types) and want to calibrate your own, or simply want to confirm sensor accuracy, you can perform a simple calibration procedure that will give you the right information.

List of Materials
Here is a list of items you will need:

- an accurate thermometer, preferably one with 0.1°C increments or better
- a bucket
- crushed or chipped ice
- a pot of boiling water
- a digital multimeter, preferably one with 0.1% resolution or better

Test Procedure
Make sure the thermistors and leads you want to test are properly potted (waterproofed), insulated or otherwise protected against moisture. You should not dip an unprotected thermistor in water since the water will short the leads and produce false readings. For this procedure use Equation 44.

1. Label each thermistor sensor so that later you can easily match it to the calibration equations you produce.

2. Allow the thermistor and thermometer to stabilize at room temperature around 25°C (77°F). Record both temperature and resistance readings, being careful not to handle both devices. This is the Mid calibration point data.

3. Fill the bucket with the crushed or chipped ice. Add water so that it overflows. Add more ice until it is tightly packed right to the bottom of the bucket (allowing water to overflow).

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

4. Insert the thermometer and the thermistor probes into the bucket ensuring that they do not touch the side or bottom of the bucket. Make sure the thermistor probes' leads are long enough for you to easily take resistance readings.

5. Cover the bucket with foam chips or another suitable insulating material. Let sit for at least five minutes while the temperature stabilizes and the thermistor has a chance to respond. Add more ice periodically, as before, ensuring that it is tightly packed to the bottom of the bucket each time. The goal is to keep the thermistor completely submerged in the ice slurry until it reaches 0°C (32°F).

6. Measure and record the resistance of the thermistor probe from the logger and the temperature from the thermometer. This is the **Low** temperature calibration point value.

7. Now insert the thermistor probe into a pot of water at room temperature and bring to a boil. Record the resistance of the thermistor probe. This is the **High** calibration point value 100°C (212°F).

8. With TrendReader software, create a thermistor equation (using the equation wizard) from the Equation Menu. Save the equation to the logger.

   CAUTION: To avoid damaging your thermistors, when calibrating, make sure you do not introduce the sensors to rapid changes in temperature (for example, from ice bucket right into the boiling water).

Calibration Procedure for Temperature Equation 45
This procedure describes how to calibrate equation 45 in TrendReader software.

Normally, you would calibrate a sensor by exposing it to 3 temperatures (0, 25 and 100°C) and entering the difference of (Measured Temperature - Actual Temperature) as Low, Mid and High calibration values. This works fine for our ET-016 temperature probes. Unfortunately, this is not possible for internal sensors since the electronics on the data logger cannot withstand a temperature of 100°C. You can simulate the calibration at 0, 25 and 100°C by creating a custom thermistor curve based on temperatures of 0, 25 and 60°C, extrapolating the curve to 100°C, and using that value for normal calibration.

TrendReader Procedure:

1. **Write a resistance equation**
   Create a custom equation of the form:
   SRC = Source0
   if SRC < 1 then SRC = 1
   if SRC > 254 then SRC = 254
   R = 10000 * SRC / (255 - SRC)
   Answer0 = R
   Save this equation.

2. **Set the internal temperature channel of the logger to the resistance equations**
   Setup the logger, change the equation number to that of the resistance equation, and save changes. Sample rate should be fairly long (about 5 minutes is good). All calibration values on the internal channel should be set to zero.

3. **Expose the logger to three known temperatures**
   For 0°C, put the logger in a watertight bag and place in ice water bath. Alternatively,

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

place in refrigeration chamber of known temperature.

For 25°C, place logger in insulated box at a known temperature close to 25°C.

For 60°C, place the logger in a watertight bag and place in a warm water bath of known temperature.

For all the rest, let the logger sit for about 2 hours to acclimatize. Record the times and the known temperature for each.

4. **Download the logger**
   After the tests are done, download the logger and graph the data. You should see 3 flat spots on the resistance curve which correspond to the times of the temperature tests. Record the value of each of the three spots.

5. **Generate a thermistor equation**
   From the Equation Menu, create a thermistor equation (using the equation wizard). Enter the low, mid and high temperatures and the corresponding resistances. Generate the equation.

6. **Revise the Logger File**
   Revise the logger file and change the equation of the internal temperature channel from your resistance equation to the new Thermistor Equation.

7. **Graph the file**
   Make sure the units are in Celsius. Check to make sure that the three flat spots occur at the known temperatures.

8. **Add three compound lines**
   On the graph, add the three compound lines. Each line should use the Thermistor equation you just created. For each of them, set the Source0 variable to Constant. The value of Constant should be 16.24 for the first line, 127.5 for the second line and 195.194 for the third line. These values correspond to the byte value that corresponds to 100, 25, 0°C under equation 45.

9. **Show the graph as a table**
   Expand the data section of the graph to view the data points. Note the value of each of the three compound lines. The first line should be close to 100°C, record that temperature as T3. The second line should be close to 25°C, record that temperature as T2. The last line should be close to zero, record that temperature as T1.

10. **Calculate the Low, Mid and High Calibration constants**
    The Low value should be equal to T1
    The Mid value should be equal to T2 - 25
    The High value should be equal to 100 - T3

11. **Final check**
    Revise the logger file again. This time, set the equation to 45 and enter the new calibration constants. Save the file under a new name. Open this new file and the first file (using the custom thermistor equation) into the same graph. Both lines should match perfectly.

12. **Calibrate the logger**
    Enter the new calibration values into the logger, set the equation to 45 and save the new changes.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.16.3 Relative Humidity Calibration

If you want to confirm the calibration of your RH sensor or EH-020A Temperature and Relative Humidity probe, you can simply return it to your authorized sales representative or perform your own field test using the special adjustment provisions in TrendReader software.

Recommended methods of calibration include using an accurate relative humidity test chamber or by mixing saturated salt solutions. Both tests are performed at an ambient room temperature of 20 to 25°C (68 to 77°F).

RH Chamber Test

If you intend to use a Relative Humidity Test Chamber for your calibration, make sure it has been recently tested to within ±1%. The procedure to calibrate is as follows:

1. Set up your humidity data logger with a sample rate of 20 seconds, and equation 81 on the RH channels. Make sure you have selected Normalized Byte data units. If you are calibrating an EH-020A module, ensure it is properly connected to the logger, and the external RH and temperature channels are enabled.

2. Start the test chamber at 5% RH and place your logger (SmartReader Plus 2 or 4) or EH-020A probe into the test chamber. Wait 20 minutes.

3. Adjust the chamber to 20% RH and wait for 20 minutes. The wait is necessary to ensure the chamber has adequate time to settle in at the desired level.

4. Adjust the chamber to 80% RH and wait an additional 20 minutes.

5. Remove your logger or RH module from the test chamber and backup the recorded information to your computer. If you are working with more than one logger, use the serial number as the file name to help match the data with the logger when you make calibration adjustments.

6. Call up the graph on your computer using TrendReader. The profile you see should reflect the test you have just performed.

7. Zoom in on the section that relates to the 20% RH level in the test chamber. Use the mouse to find the byte value recorded during the latter part of the test (refer to step 3). Record this as the "b_L" reading.

8. Zoom in on the section that relates to the 80% RH level in the test chamber. Again, use the mouse to find the byte value recorded at the end of the test (refer to step 4). Record this value as the "b_H" reading.

9. Switch to the Setup window in TrendReader software.

10. Use the following equation to calculate the "Low" calibration adjustment value:
    $Low = (63 \times b_L - 170 \times b_H) / 428$

11. For the "High" calibration adjustment value use the following equation:
    $High = 40 \times (-107 / (b_H - b_L) - 1)$

12. Now enter the same values by revising the logger file and view the corrected graphs.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

13. If the results are satisfactory, save the calibration changes to the logger (remember to set the RH channel's equation number back to 71).

Saturated Salt Test
Using saturated salt solutions is the most accurate field technique for RH calibration.

To check your humidity data logger with saturated salt solutions, gather the following equipment and materials:

- Wide mouth canning jars, 1000ml with metal lids
- #9 stoppers (Fisher #14-130N)
- Powder Funnel (Fisher #10-346-5B)
- Long Stem Funnel (Fisher #10-325D)
- Cardboard or wooden box
- Styrofoam chips (or other insulating material)
- Reagent grade salts:
  1. LiCl (anhydrous), 75gm (Fisher #L-121)
  2. MgCl2 x 6H2O, 150gm (Fisher #M-33)
  3. NaCl, 50gm (Fisher #S-271)
- De-ionized or distilled water, 75ml for each solution

Prepare for the saturated salt test by following these steps:

1. Use the powder funnel to carefully place the salt into the center of the jar bottom.

2. Slowly pour the water onto the mound of salt, using the long stem funnel, taking care not to splash any water or salt onto the inner walls of the jar.

3. Gently swirl the saturated solution. If the salt dissolves entirely, with no crystals remaining on the bottom, the solution is not saturated and more salt must be added. There must be crystals remaining on the bottom but they must not be exposed above the water level.

4. Put a nail through the jar lid and bend into a small hook. Tape the head of the nail (or use rubber cement) to create an airtight seal of the opening. The logger with RH sensor (or EH-020A) can be inserted into the jar by first hanging it on the nail loop then screwing on the lid to the jar.

5. The saturated salt solutions should be kept in a well insulated environment to minimize any temperature changes. The equilibrium RH over saturated salt solutions is only slightly temperature dependent. However, for close calibration work to 5% RH or better, it is important to keep the temperature of the salt solution and the air space above it identical. To ensure this, the temperature of the lab should be constant.

To perform the saturated salt test, follow these steps:

1. Setup your relative humidity logger with a sample rate of 20 seconds and equation 81 on the RH channel(s). Make sure you have selected Normalized Byte data units.

2. Place the jars into the box with 1 to 2 inches of Styrofoam chips on the bottom, then fill all remaining air spaces between the jars and the interior spaces of the box with the chips.

3. Cover the box with cardboard in which 6cm (2.5") diameter holes have been cut to allow access to the tops of the jars for insertion of the logger or RH module.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

4. Place the logger with sensor or EH-020A module into the jar containing the **LiCl** solution (RH = 11%) **overnight** to eliminate any hysteresis effects.

5. Quickly insert the logger (or module) into the next solution by swapping the lids. Transfers should always be made **in the direction of higher RH conditions**. The jar should be well sealed. Allow at least two hours to get within three percent of the equilibrium RH. Repeat for next solution.

Salt	RH
$MgCl_2$	33%
NaCl	75%

6. Call up the graph on your computer using TrendReader software. The profile you see should reflect the test you have just performed.

7. Zoom in on the section that relates to the 33% RH level in the test chamber. Use the mouse to find the byte value recorded during the latter part of the minimum two hour test portion (refer to step 5). Record this as the "bL" reading.

8. Zoom in on the section that relates to the 75% RH level in the test chamber. Again, use the mouse to find the byte value recorded at the end of the minimum two hour test (refer to step 5). Record this value as the "bH" reading.

9. Switch to the Setup window in TrendReader software.

10. Use the following equation to calculate the "Low" calibration adjustment value:
    $Low = (71 \times b_L - 145 \times b_H) / 296$

11. For the "High" calibration adjustment value use the following equation:
    $High = 40 \times (-74/ (b_H - b_L) - 1)$

12. Now enter the same values by revising the logger file and view the corrected graphs.

13. If the results are satisfactory, save the calibration changes to the logger (remember to set the RH channel's equation number back to 71).

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.17 APPENDIX C Thermistor Temperature Probes

Thermistor Temperature Probes

1.17.1 Thermistor Temperature Probes

The SmartReader Plus 1, 2, 4 and 8 data loggers can record temperature from a wide variety of external thermistor temperature probes. You can use the standard thermistor probes ACR makes available or you can use your own.

1.17.2 What are Thermistors?

Thermistors are temperature-sensitive resistors. The most common are those classified as the NTC (Negative Temperature Coefficient) type, which, at high temperatures, have a relatively low electrical resistance. At low temperatures their resistance is much higher. In between, the resistance varies with temperature at a predictable rate that can be made linear by a mathematical equation (refer to Equations in the TrendReader guide).

Thermistors provide a rugged, highly stable and accurate means of measuring temperature. They can be used for very low temperature applications down to -80°C (-112°F) or with special probe configurations, in environments up to 450°C (850°F).

Thermistors with consistent properties, for a given type, are readily available. These interchangeable thermistors can be substituted without recalibrating the logger.

1.17.3 ET Series Temperature Probes

The ET Series External Temperature Probes provide added versatility to the temperature measuring capabilities of your SmartReader Plus 1, 2, 4 and 8 data loggers. Accurate, interchangeable and suitable for various defined temperature ranges, they interface easily to the terminal connector block on each logger. Each ET Series Temperature Probe consists of a NTC thermistor potted into the tip of a short length of stainless steel tubing.

Equations
Each ET series thermistor probe is associated with a standard linearizing equation in TrendReader software. The equation converts the resistance values of the thermistor to accurate temperature readings, depending on the specific characteristics of the thermistor type.

Why the Different Types?
Individual thermistor types are most effectively used over specific and defined temperature

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

ranges in order to maximize measurement accuracy and resolution. In addition, some thermistor probes are constructed to accommodate special environmental or application conditions.

There are six different types of ET Series Temperature Probes available that cover a wide range of operation.

- **ET-016 General Purpose Temperature Probe** is best suited for general purpose temperature measurements centered on ambient room temperature.
- **ET-004 Low Temperature Probe** is ideal for sub-zero temperature measurements and consists of a handle with a stainless steel penetration probe (it can be used, among other applications, to monitor semi-solid frozen foods).
- **ET-081 High Temperature Probe** is best suited for higher temperature centered on 77°C (170°F).
- **ET-086 Oven Temperature Probe** is designed for even higher measurement centered on 150°C (300°F).
- **ET-016-STP** is used to monitor skin temperature on human and animals.
- **ET-016-SMP** is used to measure pipe surface temperature. It wraps around any pipe less than 2" in diameter.

If your needs for temperature measurement do not quite fit the ET series profile, you may consider using a different type of probe. The Custom Probes section in this chapter describes how you can work with other commercially-available thermistor probes from many different suppliers.

1.17.4 Setup and Use

ET series thermistor probes are easy to use and setup with your loggers. To make a probe work with your particular logger, follow the instructions for using remote thermistor probes in the chapter that deals with your SmartReader Plus model. After connecting your thermistor, make sure:

- the proper temperature equation is loaded for each enabled channel. If you do not use the correct equation, you will end up producing misleading readings.
- to check the operation of your external probes before heading out in the field by viewing the Realtime values in TrendReader software.

Probe	Range	Equation
ET-016	-35 to 95°C (-30 to 200°F)	45
ET-004	-60 to 55°C (-75 to 130°F)	46
ET-081	10 to 170°C (50 to 335°F)	47
ET-086	70 to 255°C (155 to 490°F)	48

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Extending Cable Lengths
If you find the standard length of your ET Series Temperature Probe cable is not long enough for your intended application, you can extend the cable yourself up to 30m (100ft). Use 2-conductor 22-gauge shielded wire. To prevent measurement errors, make sure the connections are properly insulated and well protected from moisture.

Applications
The ET Series Temperature Probes lend themselves to a wide range of applications. For example, to log temperatures from pipes, you can insert your ET Probe into an existing thermometer well or strap the tip of the probe to the pipe for a surface conduction temperature (for best thermal conductivity, epoxy the probe tip directly to the pipe and replace the pipe insulation back over top). You can also easily measure duct temperatures by simply drilling a hole in the duct and inserting your ET probe.

1.17.5 Specifications

ET-016 General Purpose Probe

Description:	NTC thermistor and cable potted into the end of a 25mm (1") long by 5mm (3/16") diameter cylindrical stainless steel tip.
Equation:	45
R25 Value:	10k ohms
Range:	-35 to 95°C (-30 to 200°F)
Max. Temp.:	150°C (300°F)
Resolution:	Refer to Figure C-1
Accuracy:	±0.2°C (±0.36°F) from the temperature values listed in Table C-1 over the range of 0 to 70°C (32 to 158°F) ±0.5°C (±0.9°F) from -35 to 0°C (-30 to 32°F) ±0.5°C (±0.9°F) from 70 to 120°C (158 to 248°F)
Cable:	6m (20ft) standard length with a Teflon® protective jacket;

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

red and black leads are stripped and tinned.

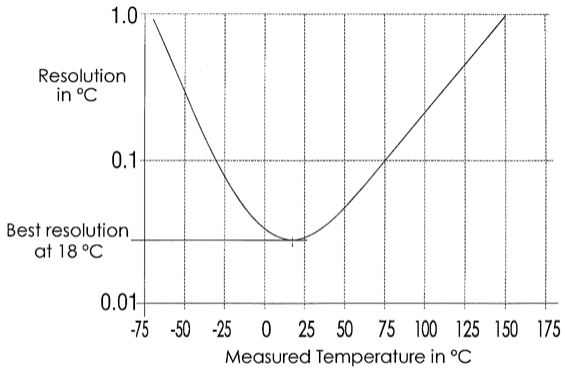


Figure C-1: ET-016 Probe Resolution

ET-016: Extended exposure to temperatures above 70°C may result in permanent resistance drift, resulting in loss of ±0.2°C tolerance over the 0 to 70°C temperature range. Extended exposure to temperatures below 0°C may result in some mechanical damage due to thermal contraction effects.

ET-004 Low Temperature Probe

Description:	NTC thermistor and cable potted into the end of a 89mm (3½ ") long tapered stainless steel penetration tip with 89mm (3½ ") long by 19mm (¾") diameter tapered plastic handle.
R25 Value:	2,252 ohms
Equation:	46
Range:	-60 to 55°C (-75 to 130°F)
Resolution:	Refer to Figure C-2
Accuracy:	±0.2°C (±0.4°F) from 0 to 55°C (32 to 130°F) ±0.6°C (±1.1°F) from -50 to -30°C (-58 to -22°F) ±0.3°C (±0.54°F) from -30 to 0°C (-22 to 32°F)
Cable:	3m (10ft) standard length with Teflon® protective jacket; red

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

and black leads are stripped and tinned.

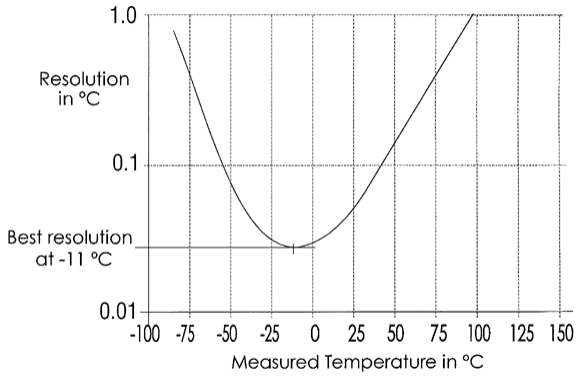


Figure C-2: ET-004 Probe Resolution

ET-081 High Temperature Probe

Description:	NTC thermistor and cable potted into the end of a 22mm (7/8") long by 5mm (3/16") diameter nickel-plated eyelet.
R25 Value:	100k ohms
Equation:	47
Range:	10 to 170°C (50 to 335°F)
Max. Temp.:	190°C (375°F)
Resolution:	Refer to Figure C-3
Accuracy:	±0.5°C (0.9°F) from the temperature values listed in Table C-1 over the range of 10 to 170°C (50 to 335°F)
Cable:	6m (20ft) standard length with twisted-pair Teflon® insulated

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

wire; red and white leads are stripped and tinned.

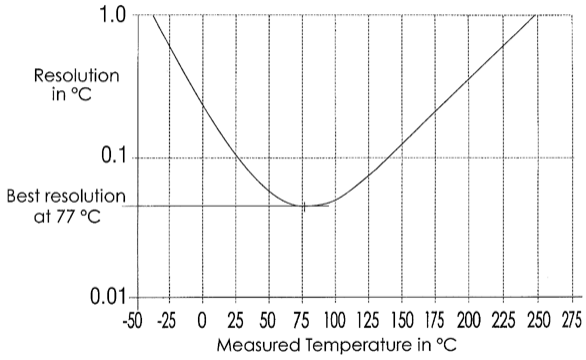


Figure C-3: ET-081 Probe Resolution

ET-086 Oven Temperature Probe

Description:	NTC thermistor and cable potted into the end of a 22mm (7/8") long by 5.5mm (7/32") diameter nickel-plated eyelet.
R125 Value:	26,266 ohms
Equation:	48
Range:	70 to 255°C (155 to 490°F)
Max. Temp.:	275°C (525°F)
Resolution:	Refer to Figure C-4
Accuracy:	±1°C (1.8°F) from the temperature values listed in Table C-1 over the range of 70 to 255°C (155 to 490°F)
Cable:	6m (20ft) standard length with twisted-pair moisture-proof Teflon®- coated glass yarn wire; white leads are stripped and

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

tinned.

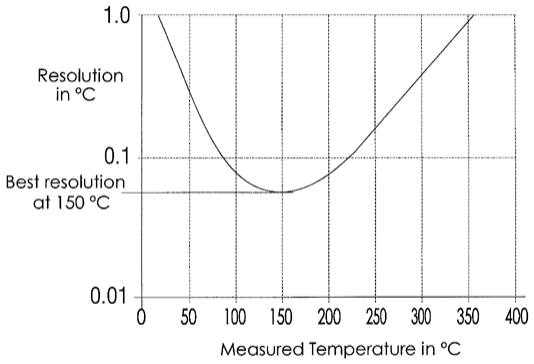


Figure C-4: ET-086 Probe Resolution

1.17.6 Resistance vs. Temperature Tables

The following table lists the Resistance vs. Temperature characteristics of the ET series thermistor probes as they relate to use with the SmartReader Plus 1, 2, 4 and 8 loggers.

For each thermistor probe model the table documents the complete set of temperature readings and corresponding thermistor resistances possible for the logger's eight most significant bits. The 12-bit reading values are normalized to a full scale value of 255; this allows the same equation to be used for both 8 and 12 bit loggers. The least significant bit of the 12-bit value is weighted 0.062 (255/4095).

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Table C-1: Temperature-Resistance Values for ET Series Probes

Byte Number	Probe Model No. Resistance (ohms)	ET-016 °C	ET-004 °C	ET-081 °C	ET-086 °C	ET-016 °F	ET-004 °F	ET-081 °F	ET-086 °F
255	5,000,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
254	2,540,000	-67.5	-84.7	-35.3	6.0	-89.4	-120.5	-31.6	42.8
253	1,265,000	-58.6	-76.9	-24.2	20.0	-73.5	-106.5	-11.6	68.0
252	840,000	-53.1	-72.2	-17.3	28.8	-63.6	-97.9	0.9	83.8
251	627,500	-49.1	-68.6	-12.1	35.3	-56.3	-91.5	10.2	95.5
250	500,000	-45.8	-65.8	-8.0	40.5	-50.5	-86.5	17.7	104.9
249	415,000	-43.1	-63.5	-4.5	44.9	-45.6	-82.3	23.9	112.8
248	354,286	-40.8	-61.5	-1.5	48.7	-41.4	-78.6	29.4	119.7
247	308,750	-38.7	-59.7	1.2	52.1	-37.7	-75.4	34.2	125.8
246	273,333	-36.8	-58.1	3.6	55.2	-34.3	-72.5	38.5	131.3
245	245,000	-35.1	-56.6	5.8	57.9	-31.3	-69.9	42.5	136.3
244	221,818	-33.6	-55.3	7.8	60.5	-28.5	-67.5	46.1	140.9
243	202,500	-32.2	-54.1	9.7	62.9	-25.9	-65.3	49.5	145.2
242	186,154	-30.8	-52.9	11.5	65.1	-23.5	-63.2	52.6	149.2
241	172,143	-29.6	-51.8	13.1	67.2	-21.2	-61.3	55.6	152.9
240	160,000	-28.4	-50.8	14.7	69.2	-19.1	-59.5	58.4	156.5
239	149,375	-27.2	-49.8	16.1	71.0	-17.0	-57.7	61.0	159.9
238	140,000	-26.2	-48.9	17.5	72.8	-15.1	-56.1	63.6	163.1
237	131,667	-25.2	-48.1	18.9	74.5	-13.3	-54.5	66.0	166.1
236	124,211	-24.2	-47.2	20.2	76.1	-11.5	-53.0	68.3	169.1
235	117,500	-23.3	-46.4	21.4	77.7	-9.9	-51.6	70.5	171.9
234	111,429	-22.4	-45.7	22.6	79.2	-8.3	-50.2	72.6	174.6
233	105,909	-21.5	-44.9	23.7	80.7	-6.7	-48.9	74.7	177.2
232	100,870	-20.7	-44.2	24.8	82.1	-5.2	-47.6	76.7	179.7
231	96,250	-19.9	-43.5	25.9	83.4	-3.7	-46.4	78.6	182.1
230	92,000	-19.1	-42.9	26.9	84.7	-2.3	-45.2	80.5	184.5
229	88,077	-18.3	-42.2	27.9	86.0	-1.0	-44.0	82.3	186.8
228	84,444	-17.6	-41.6	28.9	87.2	0.3	-42.9	84.0	189.0
227	81,071	-16.9	-41.0	29.9	88.5	1.6	-41.8	85.7	191.2
226	77,931	-16.2	-40.4	30.8	89.6	2.9	-40.7	87.4	193.3
225	75,000	-15.5	-39.8	31.7	90.8	4.1	-39.7	89.0	195.4
224	72,258	-14.8	-39.3	32.6	91.9	5.3	-38.7	90.6	197.4
223	69,688	-14.2	-38.7	33.4	93.0	6.5	-37.7	92.2	199.4
222	67,273	-13.6	-38.2	34.3	94.1	7.6	-36.7	93.7	201.4
221	65,000	-12.9	-37.7	35.1	95.1	8.7	-35.8	95.2	203.2
220	62,857	-12.3	-37.2	35.9	96.2	9.8	-34.9	96.7	205.1
219	60,833	-11.7	-36.7	36.7	97.2	10.9	-34.0	98.1	206.9
218	58,919	-11.2	-36.2	37.5	98.2	11.9	-33.1	99.5	208.7
217	57,105	-10.6	-35.7	38.3	99.1	12.9	-32.2	100.9	210.5
216	55,385	-10.0	-35.2	39.0	100.1	14.0	-31.4	102.2	212.2
215	53,750	-9.5	-34.7	39.8	101.1	14.9	-30.5	103.6	213.9
214	52,195	-8.9	-34.3	40.5	102.0	15.9	-29.7	104.9	215.6
213	50,714	-8.4	-33.8	41.2	102.9	16.9	-28.9	106.2	217.2
212	49,302	-7.9	-33.4	41.9	103.8	17.8	-28.1	107.4	218.8
211	47,955	-7.4	-32.9	42.6	104.7	18.8	-27.3	108.7	220.4
210	46,667	-6.8	-32.5	43.3	105.6	19.7	-26.5	109.9	222.0
209	45,435	-6.3	-32.1	44.0	106.4	20.6	-25.8	111.2	223.6
208	44,255	-5.8	-31.7	44.6	107.3	21.5	-25.0	112.4	225.1
207	43,125	-5.4	-31.3	45.3	108.1	22.4	-24.3	113.5	226.6
206	42,041	-4.9	-30.9	46.0	109.0	23.2	-23.5	114.7	228.1
205	41,000	-4.4	-30.5	46.6	109.8	24.1	-22.8	115.9	229.6
204	40,000	-3.9	-30.1	47.2	110.6	24.9	-22.1	117.0	231.1
203	39,038	-3.5	-29.7	47.9	111.4	25.8	-21.4	118.2	232.5
202	38,113	-3.0	-29.3	48.5	112.2	26.6	-20.7	119.3	233.9
201	37,222	-2.5	-28.9	49.1	113.0	27.4	-20.0	120.4	235.3
200	36,364	-2.1	-28.5	49.7	113.8	28.2	-19.3	121.5	236.8
199	35,536	-1.7	-28.1	50.3	114.5	29.0	-18.6	122.6	238.1
198	34,737	-1.2	-27.8	50.9	115.3	29.8	-18.0	123.7	239.5
197	33,966	-0.8	-27.4	51.5	116.0	30.6	-17.3	124.7	240.9
196	33,220	-0.3	-27.0	52.1	116.8	31.4	-16.7	125.8	242.2
195	32,500	0.1	-26.7	52.7	117.5	32.2	-16.0	126.9	243.6
194	31,803	0.5	-26.3	53.3	118.3	32.9	-15.4	127.9	244.9
193	31,129	0.9	-26.0	53.8	119.0	33.7	-14.7	128.9	246.2
192	30,476	1.4	-25.6	54.4	119.7	34.4	-14.1	130.0	247.5

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Byte Number	Probe Model No. Resistance (ohms)	ET-016 °C	ET-004 °C	ET-081 °C	ET-086 °C	ET-016 °F	ET-004 °F	ET-081 °F	ET-086 °F
191	29,844	1.8	-25.3	55.0	120.5	35.2	-13.5	131.0	248.8
190	29,231	2.2	-24.9	55.5	121.2	35.9	-12.9	132.0	250.1
189	28,636	2.6	-24.6	56.1	121.9	36.7	-12.2	133.0	251.4
188	28,060	3.0	-24.2	56.7	122.6	37.4	-11.6	134.0	252.7
187	27,500	3.4	-23.9	57.2	123.3	38.1	-11.0	135.0	253.9
186	26,957	3.8	-23.6	57.8	124.0	38.8	-10.4	136.0	255.2
185	26,429	4.2	-23.2	58.3	124.7	39.5	-9.8	136.9	256.4
184	25,915	4.6	-22.9	58.8	125.4	40.3	-9.2	137.9	257.7
183	25,417	5.0	-22.6	59.4	126.1	41.0	-8.6	138.9	258.9
182	24,932	5.4	-22.2	59.9	126.8	41.7	-8.0	139.8	260.2
181	24,459	5.8	-21.9	60.4	127.4	42.4	-7.5	140.8	261.4
180	24,000	6.1	-21.6	61.0	128.1	43.1	-6.9	141.8	262.6
179	23,553	6.5	-21.3	61.5	128.8	43.7	-6.3	142.7	263.8
178	23,117	6.9	-21.0	62.0	129.4	44.4	-5.7	143.6	265.0
177	22,692	7.3	-20.6	62.5	130.1	45.1	-5.1	144.6	266.2
176	22,278	7.7	-20.3	63.1	130.8	45.8	-4.6	145.5	267.4
175	21,875	8.0	-20.0	63.6	131.4	46.5	-4.0	146.4	268.6
174	21,481	8.4	-19.7	64.1	132.1	47.1	-3.5	147.4	269.8
173	21,098	8.8	-19.4	64.6	132.8	47.8	-2.9	148.3	271.0
172	20,723	9.2	-19.1	65.1	133.4	48.5	-2.3	149.2	272.1
171	20,357	9.5	-18.8	65.6	134.1	49.1	-1.8	150.1	273.3
170	20,000	9.9	-18.5	66.1	134.7	49.8	-1.2	151.0	274.5
169	19,651	10.3	-18.2	66.6	135.4	50.5	-0.7	152.0	275.6
168	19,310	10.6	-17.8	67.1	136.0	51.1	-0.1	152.9	276.8
167	18,977	11.0	-17.5	67.7	136.6	51.8	0.4	153.8	278.0
166	18,652	11.4	-17.2	68.2	137.3	52.4	1.0	154.7	279.1
165	18,333	11.7	-16.9	68.7	137.9	53.1	1.5	155.6	280.3
164	18,022	12.1	-16.6	69.2	138.6	53.7	2.1	156.5	281.4
163	17,717	12.4	-16.3	69.7	139.2	54.4	2.6	157.4	282.6
162	17,419	12.8	-16.0	70.1	139.8	55.0	3.1	158.3	283.7
161	17,128	13.2	-15.7	70.6	140.5	55.7	3.7	159.2	284.8
160	16,842	13.5	-15.4	71.1	141.1	56.3	4.2	160.1	286.0
159	16,563	13.9	-15.1	71.6	141.7	57.0	4.7	160.9	287.1
158	16,289	14.2	-14.8	72.1	142.4	57.6	5.3	161.8	288.3
157	16,020	14.6	-14.6	72.6	143.0	58.2	5.8	162.7	289.4
156	15,758	14.9	-14.3	73.1	143.6	58.9	6.3	163.6	290.5
155	15,500	15.3	-14.0	73.6	144.3	59.5	6.9	164.5	291.7
154	15,248	15.6	-13.7	74.1	144.9	60.2	7.4	165.4	292.8
153	15,000	16.0	-13.4	74.6	145.5	60.8	7.9	166.3	293.9
152	14,757	16.3	-13.1	75.1	146.1	61.4	8.5	167.1	295.1
151	14,519	16.7	-12.8	75.6	146.8	62.1	9.0	168.0	296.2
150	14,286	17.1	-12.5	76.1	147.4	62.7	9.5	168.9	297.3
149	14,057	17.4	-12.2	76.6	148.0	63.3	10.0	169.8	298.5
148	13,832	17.8	-11.9	77.0	148.7	64.0	10.6	170.7	299.6
147	13,611	18.1	-11.6	77.5	149.3	64.6	11.1	171.6	300.7
146	13,394	18.5	-11.3	78.0	149.9	65.2	11.6	172.4	301.8
145	13,182	18.8	-11.0	78.5	150.5	65.9	12.1	173.3	303.0
144	12,973	19.2	-10.7	79.0	151.2	66.5	12.7	174.2	304.1
143	12,768	19.5	-10.4	79.5	151.8	67.1	13.2	175.1	305.2
142	12,566	19.9	-10.2	80.0	152.4	67.8	13.7	176.0	306.4
141	12,368	20.2	-9.9	80.5	153.1	68.4	14.2	176.9	307.5
140	12,174	20.6	-9.6	81.0	153.7	69.0	14.8	177.7	308.6
139	11,983	20.9	-9.3	81.5	154.3	69.7	15.3	178.6	309.8
138	11,795	21.3	-9.0	82.0	155.0	70.3	15.8	179.5	310.9
137	11,610	21.6	-8.7	82.4	155.6	70.9	16.3	180.4	312.1
136	11,429	22.0	-8.4	82.9	156.2	71.6	16.9	181.3	313.2
135	11,250	22.3	-8.1	83.4	156.9	72.2	17.4	182.2	314.3
134	11,074	22.7	-7.8	83.9	157.5	72.8	17.9	183.1	315.5
133	10,902	23.0	-7.5	84.4	158.1	73.5	18.5	184.0	316.6
132	10,732	23.4	-7.2	84.9	158.8	74.1	19.0	184.9	317.8
131	10,565	23.7	-6.9	85.4	159.4	74.7	19.5	185.8	318.9
130	10,400	24.1	-6.6	85.9	160.0	75.4	20.0	186.7	320.1
129	10,238	24.5	-6.3	86.4	160.7	76.0	20.6	187.6	321.2
128	10,079	24.8	-6.1	86.9	161.3	76.7	21.1	188.5	322.4

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Byte Number	Probe Model No. Resistance (ohms)	ET-016 °C	ET-004 °C	ET-081 °C	ET-086 °C	ET-016 °F	ET-004 °F	ET-081 °F	ET-086 °F
127	9,922	25.2	-5.8	87.4	162.0	77.3	21.6	189.4	323.6
126	9,767	25.5	-5.5	87.9	162.6	78.0	22.2	190.3	324.7
125	9,615	25.9	-5.2	88.4	163.3	78.6	22.7	191.2	325.9
124	9,466	26.3	-4.9	88.9	163.9	79.3	23.2	192.1	327.1
123	9,318	26.6	-4.6	89.5	164.6	79.9	23.8	193.0	328.2
122	9,173	27.0	-4.3	90.0	165.2	80.6	24.3	193.9	329.4
121	9,030	27.3	-4.0	90.5	165.9	81.2	24.9	194.9	330.6
120	8,889	27.7	-3.7	91.0	166.5	81.9	25.4	195.8	331.8
119	8,750	28.1	-3.4	91.5	167.2	82.5	25.9	196.7	333.0
118	8,613	28.4	-3.1	92.0	167.9	83.2	26.5	197.7	334.2
117	8,478	28.8	-2.8	92.5	168.5	83.8	27.0	198.6	335.4
116	8,345	29.2	-2.5	93.1	169.2	84.5	27.6	199.5	336.6
115	8,214	29.5	-2.2	93.6	169.9	85.2	28.1	200.5	337.8
114	8,085	29.9	-1.8	94.1	170.6	85.8	28.7	201.4	339.0
113	7,958	30.3	-1.5	94.7	171.2	86.5	29.2	202.4	340.2
112	7,832	30.7	-1.2	95.2	171.9	87.2	29.8	203.3	341.5
111	7,708	31.0	-0.9	95.7	172.6	87.9	30.3	204.3	342.7
110	7,586	31.4	-0.6	96.3	173.3	88.5	30.9	205.3	343.9
109	7,466	31.8	-0.3	96.8	174.0	89.2	31.5	206.2	345.2
108	7,347	32.2	0.0	97.3	174.7	89.9	32.0	207.2	346.4
107	7,230	32.6	0.3	97.9	175.4	90.6	32.6	208.2	347.7
106	7,114	32.9	0.7	98.4	176.1	91.3	33.2	209.2	349.0
105	7,000	33.3	1.0	99.0	176.8	92.0	33.7	210.1	350.2
104	6,887	33.7	1.3	99.5	177.5	92.7	34.3	211.1	351.5
103	6,776	34.1	1.6	100.1	178.2	93.4	34.9	212.1	352.8
102	6,667	34.5	1.9	100.6	178.9	94.1	35.5	213.2	354.1
101	6,558	34.9	2.3	101.2	179.7	94.8	36.1	214.2	355.4
100	6,452	35.3	2.6	101.8	180.4	95.5	36.7	215.2	356.7
99	6,346	35.7	2.9	102.3	181.1	96.2	37.2	216.2	358.0
98	6,242	36.1	3.2	102.9	181.9	97.0	37.8	217.2	359.4
97	6,139	36.5	3.6	103.5	182.6	97.7	38.4	218.3	360.7
96	6,038	36.9	3.9	104.1	183.4	98.4	39.0	219.3	362.0
95	5,938	37.3	4.2	104.7	184.1	99.2	39.6	220.4	363.4
94	5,839	37.7	4.6	105.2	184.9	99.9	40.3	221.4	364.8
93	5,741	38.1	4.9	105.8	185.6	100.7	40.9	222.5	366.1
92	5,644	38.6	5.3	106.4	186.4	101.4	41.5	223.6	367.5
91	5,549	39.0	5.6	107.0	187.2	102.2	42.1	224.7	368.9
90	5,455	39.4	6.0	107.7	188.0	102.9	42.7	225.8	370.3
89	5,361	39.8	6.3	108.3	188.8	103.7	43.4	226.9	371.8
88	5,269	40.3	6.7	108.9	189.5	104.5	44.0	228.0	373.2
87	5,179	40.7	7.0	109.5	190.3	105.2	44.6	229.1	374.6
86	5,089	41.1	7.4	110.1	191.2	106.0	45.3	230.2	376.1
85	5,000	41.6	7.7	110.8	192.0	106.8	45.9	231.4	377.6
84	4,912	42.0	8.1	111.4	192.8	107.6	46.6	232.5	379.0
83	4,826	42.5	8.5	112.1	193.6	108.4	47.2	233.7	380.5
82	4,740	42.9	8.8	112.7	194.5	109.3	47.9	234.9	382.1
81	4,655	43.4	9.2	113.4	195.3	110.1	48.6	236.1	383.6
80	4,571	43.8	9.6	114.0	196.2	110.9	49.3	237.3	385.1
79	4,489	44.3	10.0	114.7	197.0	111.7	49.9	238.5	386.7
78	4,407	44.8	10.4	115.4	197.9	112.6	50.6	239.7	388.3
77	4,326	45.2	10.7	116.1	198.8	113.4	51.3	240.9	389.8
76	4,246	45.7	11.1	116.8	199.7	114.3	52.0	242.2	391.4
75	4,167	46.2	11.5	117.5	200.6	115.2	52.8	243.4	393.1
74	4,088	46.7	11.9	118.2	201.5	116.1	53.5	244.7	394.7
73	4,011	47.2	12.3	118.9	202.4	116.9	54.2	246.0	396.4
72	3,934	47.7	12.7	119.6	203.4	117.8	54.9	247.3	398.1
71	3,859	48.2	13.2	120.3	204.3	118.8	55.7	248.6	399.8
70	3,784	48.7	13.6	121.1	205.3	119.7	56.4	250.0	401.5
69	3,710	49.2	14.0	121.8	206.2	120.6	57.2	251.3	403.2
68	3,636	49.7	14.4	122.6	207.2	121.5	58.0	252.7	405.0
67	3,564	50.3	14.8	123.4	208.2	122.5	58.7	254.1	406.8
66	3,492	50.8	15.3	124.2	209.2	123.5	59.5	255.5	408.6
65	3,421	51.4	15.7	124.9	210.3	124.4	60.3	256.9	410.5
64	3,351	51.9	16.2	125.7	211.3	125.4	61.1	258.3	412.3

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Byte Number	Probe Model No. Resistance (ohms)	ET-016 °C	ET-004 °C	ET-081 °C	ET-086 °C	ET-016 °F	ET-004 °F	ET-081 °F	ET-086 °F
63	3,281	52.5	16.6	126.6	212.3	126.4	61.9	259.8	414.2
62	3,212	53.0	17.1	127.4	213.4	127.5	62.8	261.3	416.1
61	3,144	53.6	17.6	128.2	214.5	128.5	63.6	262.8	418.1
60	3,077	54.2	18.0	129.1	215.6	129.5	64.5	264.3	420.1
59	3,010	54.8	18.5	129.9	216.7	130.6	65.3	265.9	422.1
58	2,944	55.4	19.0	130.8	217.9	131.7	66.2	267.5	424.1
57	2,879	56.0	19.5	131.7	219.0	132.8	67.1	269.1	426.2
56	2,814	56.6	20.0	132.6	220.2	133.9	68.0	270.7	428.3
55	2,750	57.2	20.5	133.6	221.4	135.0	68.9	272.4	430.5
54	2,687	57.9	21.0	134.5	222.6	136.2	69.8	274.1	432.7
53	2,624	58.5	21.6	135.4	223.8	137.4	70.8	275.8	434.9
52	2,562	59.2	22.1	136.4	225.1	138.5	71.8	277.6	437.2
51	2,500	59.9	22.6	137.4	226.4	139.8	72.7	279.4	439.5
50	2,439	60.6	23.2	138.4	227.7	141.0	73.7	281.2	441.8
49	2,379	61.3	23.8	139.5	229.0	142.3	74.8	283.0	444.3
48	2,319	62.0	24.3	140.5	230.4	143.5	75.8	284.9	446.7
47	2,260	62.7	24.9	141.6	231.8	144.9	76.9	286.9	449.2
46	2,201	63.4	25.5	142.7	233.2	146.2	77.9	288.9	451.8
45	2,143	64.2	26.1	143.8	234.7	147.6	79.0	290.9	454.4
44	2,085	65.0	26.8	145.0	236.2	149.0	80.2	293.0	457.1
43	2,028	65.8	27.4	146.2	237.7	150.4	81.3	295.1	459.8
42	1,972	66.6	28.1	147.4	239.3	151.8	82.5	297.2	462.7
41	1,916	67.4	28.7	148.6	240.9	153.3	83.7	299.5	465.5
40	1,860	68.3	29.4	149.9	242.5	154.9	84.9	301.8	468.5
39	1,806	69.1	30.1	151.2	244.2	156.4	86.2	304.1	471.5
38	1,751	70.0	30.8	152.5	245.9	158.0	87.5	306.5	474.7
37	1,697	70.9	31.6	153.9	247.7	159.7	88.8	309.0	477.9
36	1,644	71.9	32.3	155.3	249.5	161.4	90.2	311.5	481.2
35	1,591	72.9	33.1	156.7	251.4	163.1	91.6	314.1	484.6
34	1,538	73.9	33.9	158.2	253.4	164.9	93.1	316.8	488.1
33	1,486	74.9	34.7	159.8	255.4	166.8	94.5	319.6	491.7
32	1,435	76.0	35.6	161.4	257.5	168.7	96.1	322.5	495.5
31	1,384	77.1	36.5	163.1	259.6	170.7	97.7	325.5	499.4
30	1,333	78.2	37.4	164.8	261.9	172.7	99.3	328.6	503.4
29	1,283	79.4	38.3	166.6	264.2	174.9	101.0	331.8	507.5
28	1,233	80.6	39.3	168.4	266.6	177.1	102.8	335.1	511.9
27	1,184	81.9	40.3	170.3	269.1	179.3	104.6	338.6	516.4
26	1,135	83.2	41.4	172.3	271.7	181.7	106.5	342.2	521.1
25	1,087	84.5	42.5	174.4	274.4	184.2	108.5	346.0	526.0
24	1,039	86.0	43.6	176.6	277.3	186.8	110.5	349.9	531.1
23	991	87.5	44.8	178.9	280.3	189.5	112.7	354.0	536.5
22	944	89.1	46.1	181.3	283.4	192.3	114.9	358.4	542.2
21	897	90.7	47.4	183.8	286.7	195.3	117.3	362.9	548.1
20	851	92.4	48.8	186.5	290.2	198.4	119.8	367.7	554.4
19	805	94.3	50.2	189.4	293.9	201.7	122.4	372.8	561.1
18	759	96.2	51.8	192.4	297.9	205.2	125.2	378.3	568.2
17	714	98.3	53.4	195.6	302.1	208.9	128.1	384.0	575.7
16	669	100.5	55.1	199.0	306.6	212.9	131.3	390.2	583.8
15	625	102.9	57.0	202.7	311.4	217.2	134.6	396.9	592.5
14	581	105.4	59.0	206.7	316.7	221.8	138.2	404.1	602.0
13	537	108.2	61.2	211.1	322.4	226.7	142.2	411.9	612.2
12	494	111.2	63.6	215.8	328.6	232.2	146.4	420.5	623.5
11	451	114.5	66.2	221.1	335.5	238.1	151.1	429.9	635.9
10	408	118.2	69.1	226.9	343.2	244.8	156.3	440.5	649.8
9	366	122.3	72.3	233.5	351.9	252.2	162.1	452.4	665.5
8	324	127.0	75.9	241.1	361.9	260.7	168.7	466.0	683.4
7	282	132.5	80.2	249.9	373.5	270.4	176.3	481.8	704.4
6	241	138.9	85.1	260.4	387.4	282.0	185.2	500.7	729.4
5	200	146.7	91.1	273.3	404.5	296.0	196.0	523.9	760.2
4	159	156.6	98.7	289.8	426.6	313.8	209.7	553.6	799.8
3	119	169.9	108.9	312.5	457.0	337.9	228.0	594.5	854.5
2	79	190.1	124.1	347.6	504.2	374.2	255.4	657.7	939.5
1	39	228.8	152.9	417.8	599.8	443.9	307.1	784.0	1111.6
0	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.17.7 Custom Probes

Obtaining thermistors through specialty suppliers allows you wider flexibility in the number of possible probe assemblies for your specific applications. That way, if you have a special surface, penetration, pipe well or immersion sensing applications, you can usually get off-the-shelf or even custom probes to suit. Contact your dealer for recommendations.

Writing Your Own Thermistor Equations

Each thermistor temperature probe you use with SmartReader Plus data loggers must be associated with a standard or custom equation in TrendReader software. This equation translates the internal digital logger readings for the specific thermistor, or thermistor type, into the units of your choice (e.g. degrees Celsius or Fahrenheit).

TrendReader software includes a function that can automatically create custom equations for use with your own thermistors. See Equations in the TrendReader guide.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.18 APPENDIX D Typical SmartReader Plus 3 Connection Diagram

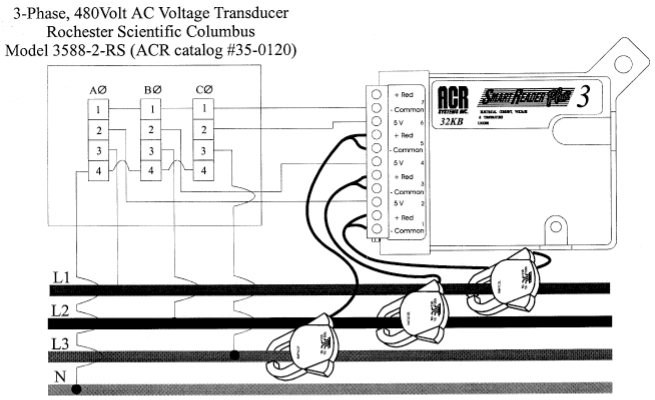
Typical SmartReader Plus 3 Connection Diagram

1.18.1 AC Current and AC Voltage Recording

ACR Systems stocks voltage transducers. These devices connect directly to AC voltage sources, and produce a linear output of 0-5V DC directly proportional to the input voltage. They are average-sensing transducers calibrated to indicate the RMS voltage.

We stock two models: a 120V single-phase model, and a 480V 3-phase model.

480Volt 4-Wire Wye Power System



480Volt 3-Wire Delta Power System

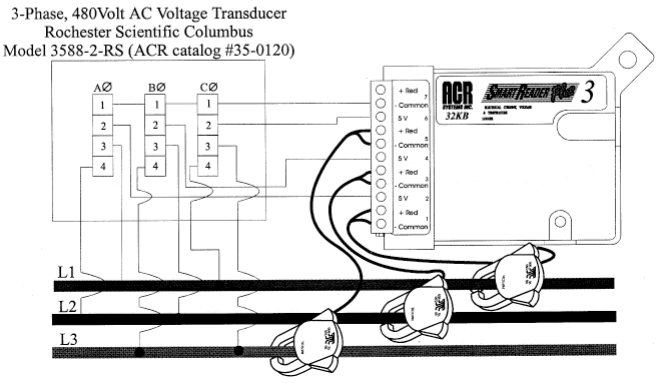


Figure D-1: 480V Power Systems

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

1.18.2 AC Voltage Transducer Specifications

Voltage Input

	Single phase	3-phase
Nominal:	120V	480V
Range:	0-150V	0-600V
Overload Continuous:	180V	600V
Burden per Element:	2.5VA at 120V	2.5VA at 480V
Rated Output (RO):	0-5VDC Can be changed to 0-1mA by removing the 5k ohms resistor	
Accuracy:	±(0.15% Reading + 0.1% RO)	
Temp Effect on Accuracy:	±0.01% / °C	
Load with 0-1mA Output:	0-10,000 ohms	
Load with 0-5VDC Output:	5M ohms minimum	
Output Ripple Peak:	< 0.25% RO	
Response Time:	< 400 ms to 99%	
Standard Calibration Adjustments:	±10% of reading	
Frequency Range:	60Hz	
Stability (per year):	±0.25% RO Non-Accumulative	
Operating Humidity:	0-95% Non-Condensing	
Dielectric Withstand:	1500 VRMS at 60Hz	
Isolation:	Complete Input/Output/Case	
Surge Withstand:	ANSI/IEEE C37.90.1	
Maximum Net Weight:		
VT110A2-RS:	14oz, (0.4kg)	
3588-2-RS:	28oz, (0.8kg)	
Approximate Dimensions:		
VT110A2-RS:	3.1"W X 2"D X 4.1"H 79 X 51 X 104mm)	

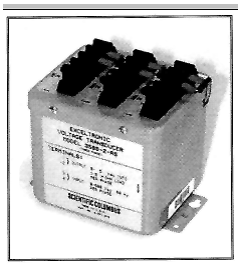
Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

3588-2-RS:	4.4"W x 3.8"D x 4.7"H (112 x 97 x 119mm)

VT110A2-RS (cat# 35-0110)
120V single-phase model

Figure D-2: 120V Voltage Transducer



3588-2-RS (cat# 35-0120)
480V 3-phase model

Figure D-3: 480V Voltage Transducer

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.19 APPENDIX E Sample Rates

Sample Rates

1.19.1 How a Data Logger Stores Readings

The sample rate of your data logger is the frequency with which it stores readings in its memory. A selected sample will apply for all channels on a SmartReader Plus.

If you set your data logger's sample rate to eight seconds, it reads its input channels and stores the readings once every eight seconds. If you choose a sample rate longer than eight seconds, the logger still reads its input channels once every eight seconds, and stores an averaged reading at the end of the sample interval you have chosen.

For example, if you use a two-minute sample rate, the data logger takes fifteen separate readings over each two-minute interval. At the end of each two-minute interval, the logger calculates the average of the fifteen readings, and stores that average in its memory.

1.19.2 Sample Rate Tables

The following tables list the maximum time spans over which your SmartReader Plus will record readings. The time spans depend on the number of channels enabled and the length of the sample rate. A SmartReader Plus-32K has a memory capacity of 21,500 readings. A SmartReader Plus-128K can store 87,000 readings and a 1.5 MB version can store 1,048,000 readings.

In each table, the *Sample Rate* column lists the available sample rates. The *Days, Hours, Minutes* and *Seconds* columns list the time spans over which your logger will record readings at each sample rate.

For example, a SmartReader Plus-32K with two channels enabled, using a sample rate of ten minutes, will store readings for 74 days, 15 hours and 40 minutes. After that time, depending on how it was set up, the logger will either continue to take readings and replace the oldest readings with the new readings, or it will stop taking readings.

Table F-1: SmartReader Plus-32K Sample Rate - One Channel Enabled

Sample Rate	Days	Hours	Minutes	Seconds
0.04 sec.	0	0	14	20
0.1 sec.	0	0	35	50
0.2 sec.	0	1	11	40
0.5 sec.	0	2	59	10
1 sec.	0	5	58	20

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

2 sec.	0	11	56	40
5 sec.	1	5	51	40
8 sec.	1	23	46	40
20 sec.	4	23	26	40
1 min.	14	22	20	0
2 min.	29	20	40	0
5 min.	74	15	40	0
10 min.	149	7	20	0
30 min.	447	22	0	0
1 hr.	895	20	0	0
2 hrs.	1791	16	0	0
4 hrs.	3583	8	0	0

Table F-2: SmartReader Plus-32K Sample Rate Table - Two Channels Enabled

Sample Rate	Days	Hours	Minutes	Seconds
0.04 sec.	0	0	7	10
0.1 sec.	0	0	17	55
0.2 sec.	0	0	35	50
0.5 sec.	0	1	29	35
1 sec.	0	2	59	10
2 sec.	0	5	58	20
5 sec.	0	14	55	50
8 sec.	0	23	53	20
20 sec.	2	11	43	20
1 min.	7	11	10	0
2 min.	14	22	20	0
5 min.	37	7	50	0
10 min.	74	15	40	0
30 min.	223	23	0	0
1 hr.	447	22	0	0
2 hrs.	895	20	0	0
4 hrs.	1791	16	0	0

Table F-3: SmartReader Plus-32K Sample Rate - Three Channels Enabled

Sample Rate	Days	Hours	Minutes	Seconds
0.04 sec.	0	0	4	46

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

0.1 sec.	0	0	11	56
0.2 sec.	0	0	23	53
0.5 sec.	0	0	59	43
1 sec.	0	1	59	26
2 sec.	0	3	58	53
5 sec.	0	9	57	13
8 sec.	0	15	55	33
20 sec.	1	15	48	53
1 min.	4	23	26	40
2 min.	9	22	53	20
5 min.	24	21	13	20
10 min.	49	18	26	40
30 min.	149	7	20	0
1 hr.	298	14	40	0
2 hrs.	597	5	20	0
4 hrs.	1194	10	40	0

Table F-4: SmartReader Plus-32K Sample Rate - Four Channels Enabled

Sample Rate	Days	Hours	Minutes	Seconds
0.04 sec.	0	0	3	35
0.1 sec.	0	0	8	57
0.2 sec.	0	0	17	55
0.5 sec.	0	0	44	47
1 sec.	0	1	29	35
2 sec.	0	2	59	10
5 sec.	0	7	27	55
8 sec.	0	11	56	40
20 sec.	1	5	51	40
1 min.	3	17	35	0
2 min.	7	11	10	0
5 min.	18	15	55	0
10 min.	37	7	50	0
30 min.	111	23	30	0
1 hr.	223	23	0	0
2 hrs.	447	22	0	0
4 hrs.	895	20	0	0

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Table F-5: SmartReader Plus-32K Sample Rate - Five Channels Enabled

Sample Rate	Days	Hours	Minutes	Seconds
0.04 sec.	0	0	2	52
0.1 sec.	0	0	7	10
0.2 sec.	0	0	14	20
0.5 sec.	0	0	35	50
1 sec.	0	1	11	40
2 sec.	0	2	23	20
5 sec.	0	5	58	20
8 sec.	0	9	33	20
20 sec.	0	23	53	20
1 min.	2	23	40	0
2 min.	5	23	20	0
5 min.	14	22	20	0
10 min.	29	20	40	0
30 min.	89	14	0	0
1 hr.	179	4	0	0
2 hrs.	358	8	0	0
4 hrs.	716	16	0	0

Table F-6: SmartReader Plus-32K Sample Rate - Six Channels Enabled

Sample Rate	Days	Hours	Minutes	Seconds
0.04 sec.	0	0	2	23
0.1 sec.	0	0	5	58
0.2 sec.	0	0	11	56
0.5 sec.	0	0	29	51
1 sec.	0	0	59	43
2 sec.	0	1	59	26
5 sec.	0	4	58	36
8 sec.	0	7	57	46
20 sec.	0	19	54	26
1 min.	2	11	43	20
2 min.	4	23	26	40
5 min.	12	10	36	40
10 min.	24	21	13	20
30 min.	74	15	40	0
1 hr.	149	7	20	0

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

2 hrs.	298	14	40	0
4 hrs.	597	5	20	0

Table F-7: SmartReader Plus-32K Sample Rate - Seven Channels Enabled

Sample Rate	Days	Hours	Minutes	Seconds
0.04 sec.	0	0	2	2
0.1 sec.	0	0	5	7
0.2 sec.	0	0	10	14
0.5 sec.	0	0	25	35
1 sec.	0	0	51	11
2 sec.	0	1	42	22
5 sec.	0	4	15	57
8 sec.	0	6	49	31
20 sec.	0	17	3	48
1 min.	2	3	11	25
2 min.	4	6	22	51
5 min.	10	15	57	8
10 min.	21	7	54	17
30 min.	63	23	42	51
1 hr.	127	23	25	42
2 hrs.	255	22	51	25
4 hrs.	511	21	42	51

Table F-8: SmartReader Plus-32K Sample Rate - Eight Channels Enabled

Sample Rate	Days	Hours	Minutes	Seconds
0.04 sec.	0	0	1	47
0.1 sec.	0	0	4	28
0.2 sec.	0	0	8	57
0.5 sec.	0	0	22	23
1 sec.	0	0	44	47
2 sec.	0	1	29	35
5 sec.	0	3	43	57
8 sec.	0	5	58	20
20 sec.	0	14	55	50
1 min.	1	20	47	30
2 min.	3	17	35	0

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

5 min.	9	7	57	30
10 min.	18	15	55	0
30 min.	55	23	45	0
1 hr.	111	23	30	0
2 hrs.	223	23	0	0
4 hrs.	447	22	0	0

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.20 APPENDIX F Connecting Multiple Loggers

Connecting Multiple Loggers

1.20.1 Network Configurations

SmartReader Plus data loggers can be connected in three network configurations:

- the Basic Network
- the Modular Network
- the Shielded Network

The Basic Network can accommodate up to three loggers and a total cable length of 100 feet (30m). The Modular and Shielded Networks can accommodate up to ten loggers and a total cable length of 1000 feet (300m). The Shielded Network is used in electrically noisy environments.

The table below shows the equipment needed for each network.

Network Configuration	Maximum # of Loggers	Total Cable Length	Computer/ Modem Connection	Network Cable	Logger Connections	External Power to Last Logger
Basic Network	3	100 ft. (30m)	IC-101 Interface Cable	CB-020 20 ft. (6m) Extension Cable	YA-200 Y-Adaptor Cable	Optional*
Modular Network	10	1000 ft. (300m)	IC-101 Plug and YA-201 Modular Y-adaptor	Modular Flat Cable	YA-201 Modular Y-Adaptor (except to last logger)	PS-201 Network Power Supply and YA-200 Y-Adaptor
Shielded Network	10	1000 ft. (300m)	IC-101 Interface Cable	Shielded Cable	YA-200 Y-Adaptor Cable	PS-201 Network Power Supply

*PS-201 Network Power Supply may be required for some computers or modems.

Note that once the hardware has been set up you will need to set up a Network List for the loggers you are going to connect.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.20.2 Basic Network

The Basic Network accommodates a maximum of three loggers.

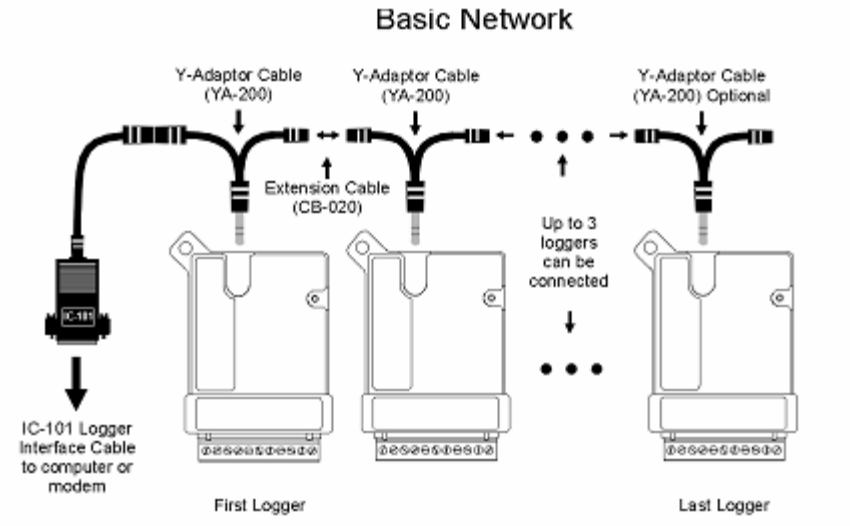


Figure G-1: Basic SmartReader Plus Network

1. Insert Y-adaptor cables (YA-200) into each logger except the last one on the network.

2. Connect the first logger to your computer (or remote modem) using the IC-101 interface cable. If you are connecting to a modem, refer to the TrendReader guide for information on how to set up a modem.

3. Connect the loggers together with extension cables (CB-020).

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.20.3 Modular Network

The Modular Network accommodates a maximum of ten loggers.

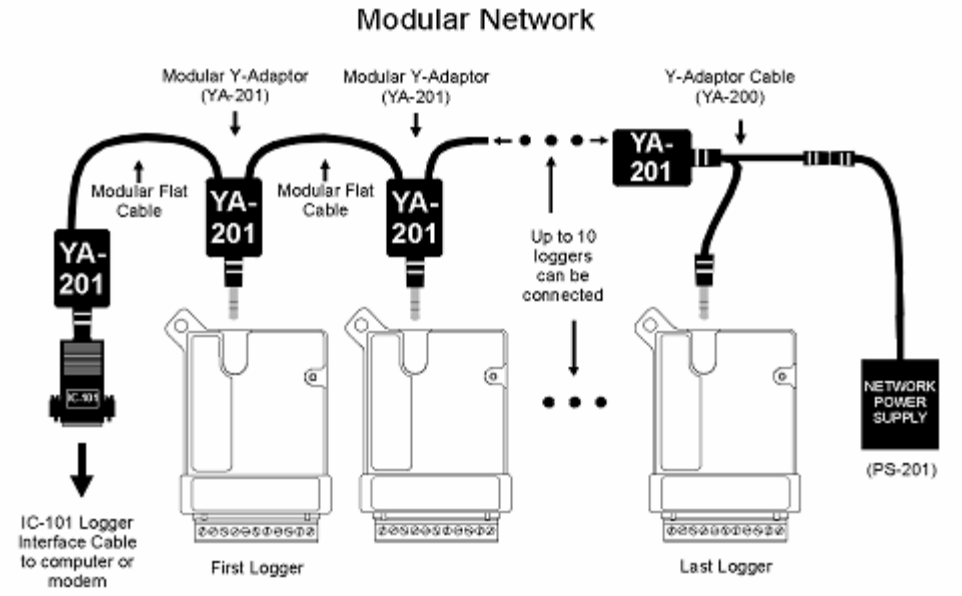


Figure G-2: Modular SmartReader Plus Network

1. Insert a Y-adaptor cable (YA-200) into the last logger on the network.
2. Insert a Modular Y-adaptor (YA-201) into:
   - the plug portion of the IC-101 Interface Cable
   - each logger except the last one on the network
   - one end of the last logger's Y-adaptor cable
3. Cut and crimp the Modular Flat Cable.

   NOTE: Do not use modular cable crimped for telephone use as the wiring will be "mirror image". Instead, crimp your own jacks using a "straight through" wiring method.
4. Connect the IC-101 to the first logger, and all the loggers to each other, using Modular Flat Cable.
5. Connect the Network Power Supply (PS-201) to the last logger using the available end of the Y-adaptor cable.
6. Plug the power supply into an electrical outlet.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1.20.4 Shielded Network

The Shielded Network accommodates a maximum of ten loggers.

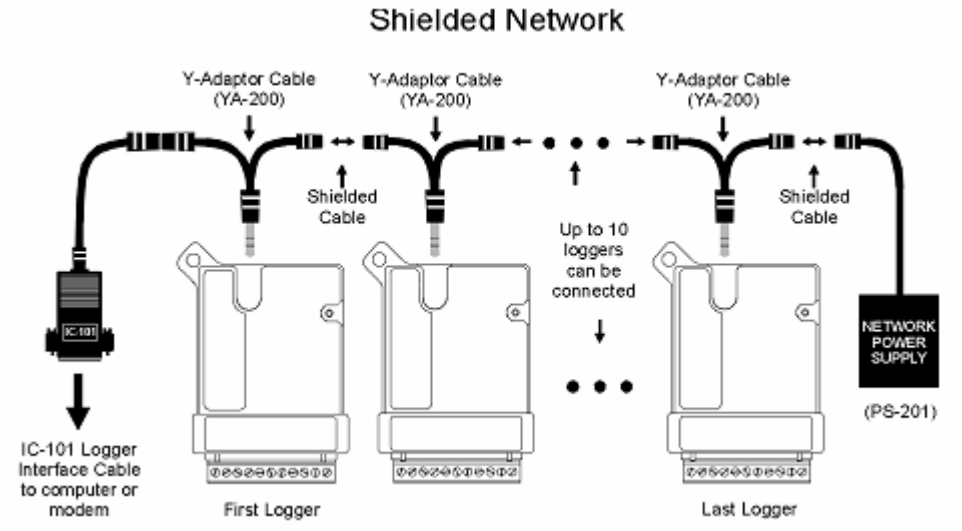


Figure G-3: Shielded SmartReader Plus Network

1. Insert Y-adaptor cables (YA-200) into each logger on the network.
2. Connect the IC-101 Interface Cable to the first logger.
3. Connect all the loggers to each other, using shielded cable.
4. Connect the Network Power Supply (PS-201) to the last logger using the available end of the Y-adaptor cable.
5. Plug the power supply into an electrical outlet.

1.20.5 Connection Problems and Solutions

Network communication can be affected by:

- network cable length
- type of network cable
- number of loggers on network
- interference from electrical equipment
- lack of external power supply

If you have problems communicating with loggers on a network please try the following steps:

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

1. Slow the baud rate.
2. Use the PS-201 Power Supply connected to the last logger on the network, or anywhere along the line, wherever the lone voltage may sag below 4.5VDC.
3. Reroute the cable (to avoid electrical interference).
4. Use shielded cable.

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Index

- A -

AC Current 91
AC Voltage
  Transducer 33, 91

- C -

Calibration 73
Connecting Multiple Loggers 100
Count 62
Current 50
  Probe 33

- D -

Data Logger 1

- E -

EH-020A 28, 38, 42, 73
ET Series
  ET-004 Low Temperature Probe 79
  ET-016 General Purpose Probe 79
  ET-081 High Temperature Probe 79
  ET-086 Oven Temperature Probe 79

- L -

Logger 1
LPD
  Low Pressure Differential 42

- N -

Network 100

- P -

Pressure
  Sensor 38, 42
Process Signal 50
Pulse 62

- R -

Resistance 71
RH
  Probe 28, 38, 42, 73
  Relative Humidity 28, 38, 42, 73
  Relative Humidity Probe 28, 38, 42, 73
  RH 73
  Sensor 28, 38, 42
RTD
  Resistance Temperature Detector 65

- S -

Sample Rates 94
SmartReader Plus
  Alarms 8
  Approvals 1
  Calibration 8
  Channel Alarms 21
  Channel Calibration 21
  Channel Information 19
  Channels 8, 19
  Data Logger 1
  Description 1
  Dialout 8
  Fast 8
  Fast Sampling 10
  Features 1
  Introduction 1
  Logger 1
  Logger Alarms 14
  Logger Connection Settings 22
  Memory 8, 11
  Operation 1
  Readings 1
  Sampling 8, 10
  Setup 8
  Software 8
  Specifications 1
  Status 8, 9
  Unknown Equation 19
SmartReader Plus 1 26
SmartReader Plus 10 65
SmartReader Plus 2 28
SmartReader Plus 3 33
SmartReader Plus 4 38
SmartReader Plus 4 LPD 42
SmartReader Plus 5 44
SmartReader Plus 6 47
SmartReader Plus 7 50
SmartReader Plus 8 60
SmartReader Plus 9 62
SRP 1
Switch 71
  Contact 62

- T -

Temperature 44, 47
  Probe 26, 28, 38, 42, 60, 65, 73, 79
Thermistor 26, 60, 73, 79

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

Thermocouple
E Type 44, 47
J Type 44, 47
K Type 44, 47
S Type 44, 47
T Type 44, 47
Transducer 50
Transmitter 50

- V -

Voltage 33, 50

Copyright © 2010 ACR Systems Inc. All Rights Reserved.

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524

ACR Systems Inc.

Building 210 - 12960 84th Ave.
Surrey, British Columbia, Canada V3W 1K7

Telephone: (604) 591-1128
North American Toll Free: 1-800-663-7845
Fax: (604) 591-2252

General Enquiries Email: enquiry@acrsystems.com
Sales Department Email: sales@acrsystems.com
Customer Service Email: customerservice@acrsystems.com
www.acrsystems.com

Distributed by MicroDAQ.com, Ltd. www.MicroDAQ.com (603) 746-5524